FISHERIES REPORT
19-08

REGION IV
TROUT FISHERIES REPORT
2018

Prepared by:

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Tennessee Wildlife Resources Agency

Above photo: A large (28.9 in., 10 lb.) Brown Trout from the Ft. Patrick Henry tailwater near Kingsport. A new management plan was developed in 2018 for the trout fisheries in this tailwater and the nearby Boone tailwater. Photo by J. Habera (TWRA).

Cover photo: TWRA fisheries crew partnering with US Forest Service personnel on the Green Mountain Branch Brook Trout restoration in 2018. Partnerships are imperative for successful restoration projects. Photo by Marcia Carter (USFS).

Visit TWRA's website at www.tnwidlife.org, where you can learn more about Tennessee's trout fisheries across the state.

REGION 4

TROUT FISHERIES REPORT
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TENNESSEE WILDLIFE RESOURCES AGENCY

July 2019

This report contains progress and accomplishments for the following TWRA Projects: "Stream Survey".

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Executive Summary

Long term monitoring streams: Five wild trout streams were quantitatively sampled during the 2018 field season (June-October). Overall, trout abundance remained below long term averages. This is likely due to lingering effects of the abnormally dry to extreme drought conditions from May 2016 to mid-April 2017 in eastern Tennessee (United States Drought Monitor). Drought conditions can decrease base stream flow and increase temperatures, which can limit adult recruitment.

Sympatric Brook/Rainbow Trout streams: Relative Brook Trout biomass decreased in all of the streams sampled this year. Data from these stations continue to document long-term co-existence of Brook and Rainbow Trout and that drier periods (particularly 1998-2002; 2007-2008) favor Brook Trout while wetter periods (e.g., 2003-2005, and 2013) or floods (1994) favor Rainbow Trout.

Native Brook Trout Restoration and Enhancement: Progress was made in 2018 on five Tier 1 and two Tier 2 Brook Trout projects. Little Stony Creek was stocked with 279 fingerling Brook Trout in the lower 600 meters of that project area with fish propagated from TNACI. Another stocking there is planned for 2019 and will conclude this restoration. The lower 300 m reach of Little Jacob Creek was stocked with 180 Brook Trout translocated from Fagall Branch, Heaberlin Branch and East Fork Beaverdam Creek, concluding this enhancement project. Fish passage barriers were located on Trail Fork Big Creek and Green Mountain Branch and Rainbow Trout removal efforts (electrofishing) were initiated. Plans for these Tier 1 projects in 2019 include completion of Rainbow Trout removal and, if no Rainbow Trout reproduction occurred, translocation of genetically-appropriate native Brook Trout into these streams in the fall. Progress was also made identifying potential Brook Trout donor streams in the Nolichucky River watershed NC, through a partnership with the NC Wildlife Resources Commission, for a restoration project in Phillips Hollow. Sinking Creek and Right Prong Rock Creek (Tier 2 projects) were checked for fish passage barriers, and potential barriers were located on Right Prong Rock Creek and a tributary. Additional work is needed on these streams to determine their potential for successful native Brook Trout restorations.

Norris tailwater: The mean electrofishing catch rate for all trout ≥178 mm (254 fish/h) and for Rainbow Trout (213 fish/h) in 2018 were the highest observed to date. While the mean electrofishing catch rate for trout within the PLR (356-508 mm) declined to 56 fish/h, it remained above the current Norris tailwater management plan (2014-2019) objective of 28 fish/h. The relative stock density of trout 356 mm (14 in.) and larger (RSD-14) increased from 12 (2009) to over 40 during 2014-17, indicating that trout population size structures have been shifted toward larger fish. However, RSD-14 decreased to 29 in 2018, partially as a result of the increased fish abundance. The angler survey conducted in 2017 indicated that pressure, trips, catch, and harvest all declined relative to the previous survey in 2015. The overall harvest rate (13%) was similar to recent harvest rates for the South Holston (13%, 2017) and Wilbur (10 %, 2016) tailwaters. Fingerling Rainbow Trout from the Norris tailwater were collected and screened in 2018 for the parasite that causes whirling disease (Myxobolus cerebralis), but results were negative.

Cherokee tailwater: The Cherokee tailwater was sampled in both June and October 2018. The mean electrofishing catch rate for the June sample (18 fish/h ≥178 mm) exceeded all previous fall samples, but by only a small margin (maximum of 16 fish/h in 2012). The electrofishing catch rate for the subsequent October sample in 2018 declined (as expected) to 9.5 fish/h. Given the presence of trout >457 mm (18 in.) in both 2018 sample and in most previous fall samples, it is evident that some trout (both species) survive the September/October thermal bottleneck. Water temperatures in the Cherokee tailwater were generally cooler in 2018 (relative to 2017). However, there was no coldwater habitat (minimum daily water temperature exceeded 21° C) for 43 days near the dam and 42 days at Blue Spring. Water temperatures in the Cherokee tailwater typically return to trout-tolerant levels (<21° C) by mid- to late October, and this occurred on 26 October in 2018.

Wilbur tailwater: The mean electrofishing catch rate for all trout (≥178 mm) decreased somewhat to 235 fish/h in 2018. The catch rate for Brown Trout in the lower half of the tailwater (49 fish/h) met the management plan (2015-2020) objective of 40 fish/h (≥178 mm) and has averaged 47 fish/h since 2015. A low-flow qualitative electrofishing survey of the lower portion of the tailwater was conducted in September 2018 to assess the presence of Striped Bass *Morone saxatilis* given concerns expressed by anglers about trout predation. Six Striped Bass were observed in the 6.5-km reach extending down to the Hwy. 400 bridge, along with several large (>508 mm) Brown Trout. Mean electrofishing catch rates (trout ≥178 mm) for monitoring stations in that reach show no trend since 2013. A new angler survey was conducted in 2018 and 60% of those interviewed indicted they were aware of the presence of the whirling disease parasite. Most anglers (66%) cited the Agency's Fishing Guide as the source of their information, while another 16% learned from other anglers and 11% learned from the Agency's website.

Ft. Patrick Henry tailwater: The mean electrofishing catch rate for all trout ≥178 mm decreased 58% (to 44 fish/h) in 2018. Mean catch rates for larger trout (≥356 mm and ≥457 mm) also decreased (to 27 fish/h and 7 fish/h, respectively), but RSD-18 increased slightly to 23. The angler survey conducted in 2017 estimated 13,423 hours of effort and 4,278 trips. Anglers caught an estimated 16,481 trout (93% Rainbow Trout) and harvested 24% of these. A management plan for the Boone and Ft. Patrick Henry tailwaters (2019-2024) was completed in 2018. The management goal for Ft. Patrick Henry is to fully develop and maintain its potential—particularly for producing the large, well-conditioned Rainbow Trout—thus providing exceptional angling opportunities.

Boone tailwater: Although the mean electrofishing catch rate for Rainbow Trout ≥178 mm decreased 33% (to 41 fish/h) in 2018, the catch rate for all trout ≥178 mm (110 fish/h) remained relatively unchanged because of the atypically high catch rate for Brook Trout (48 fish/h). However, no Brook Trout in 2018 were >325 mm. The catch rate for both Rainbow Trout and Brown Trout ≥356 mm decreased relative to 2017, although Rainbow Trout RSD-18 recovered to 14 (from 0 in 2017). Repairs at Boone Dam requiring a drawdown of 3.1 m (10') below winter pool continued in 2018. TVA water quality monitoring data from the tailwater near the dam indicated water temperature reached 21°C on eight days during late July through mid-August 2018 and reached the 22-23°C range only briefly (≤1 h) on two of those days. Dissolved oxygen (DO) levels in the 4.0-6.0 mg/l range routinely occurred on 26 days during July-August of 2018. Currently, no effects on the tailwater trout fishery are evident. A management plan for the Boone and Ft. Patrick Henry tailwaters (2019-2024) was completed in 2018. The management goal for the Boone tailwater is to fully develop and maintain its potential—particularly for producing the large, well-conditioned Rainbow Trout—thus providing exceptional angling opportunities.

South Holston tailwater: Both the mean electrofishing catch rate for all trout ≥178 mm (242 fish/h) and the catch rate for trout in the 406-559 mm PLR (9.0 fish/h) declined again (slightly) in 2018. However, the PLR catch rate for Brown Trout increased from 7.5 to 8.5 fish/h and relative stock density for Brown Trout ≥406 mm (RSD-16) increased from 4 to 7 (but remains well below the 2004-2007 average of 15. If overall trout abundance (CPUE) equilibrates closer to 200 fish/h and angler harvest rates for Brown Trout increase from the current 4.9%, RSD-16 should further improve. The angler survey conducted on the South Holston tailwater in 2017 indicated that pressure (86,082 h) and trips (16,405) decreased 35% and 32%, respectively, relative to the 2014 survey. Catch (147,641) and harvest (18,718) also decreased substantially (48% and 26%, respectively). There was a slight increase in the Brown Trout harvest rate (from 3.5% to 4.9%), and the overall harvest rate increased from 9% to 13%. A sample of Rainbow Trout fingerlings (n=60) was collected at three sites throughout the tailwater in July at the request of the

Southeastern Cooperative Fish Parasite and Disease Lab (Auburn University), which conducted all Myxobolus screening for TWRA in 2018. The screening results were positive but interestingly, no fingerling Rainbow Trout had been stocked at that point in 2018, so these fish (<100 mm) must have been the result of natural reproduction—which may be more substantial than previously understood.

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1. INTRODUCTION

The Tennessee Wildlife Resources Agency (TWRA) manages trout fisheries in a variety of waters in Tennessee including streams, tailwater rivers, and reservoirs. Together, these fisheries provide a popular and important set of angling opportunities. The U.S. Fish and Wildlife Service (USFWS) conducts nationwide surveys every five years to track trends in sport fishing and other outdoor recreation activities. The most recent survey providing demographic and economic data for trout angling (2011), estimated that 105,000 resident and non-resident anglers (age 16 or older) fished for trout in Tennessee (Maillett and Aiken 2015). They made an estimated 1.4 million trips and represented 15% of all Tennessee anglers (Maillett and Aiken 2015). The estimated total expenditure associated with these trips was approximately $53 million. Compared with the previous survey (2006; Harris 2010), the estimated number of trout anglers increased 10%, while trips increased 40%. A statewide survey by the University of Tennessee in 2012 also indicated that 15% of Tennessee's anglers fished for trout, making an average of 15 trips (averaging 4 hours) that year (Schexnayder et al. 2014). Most of those anglers targeted trout in hatchery-supported fisheries. Accordingly, while Agency management emphasizes habitat preservation and maintenance of wild stocks where they occur, artificially propagated trout are essential for managing substantial portions of the coldwater resource. In 2018, 686,024 pounds of trout (~2.03 million fish) produced or grown primarily at five state (TWRA), one municipal (Gatlinburg), and two federal (USFWS) facilities were stocked to manage Tennessee's hatchery-supported fisheries (Roddy 2018). Nearly half (311,592 pounds) were stocked in Region IV waters, with 35% (109,617 pounds) of those trout used to support tailwater fisheries and another 20% (63,525 pounds) used to provide reservoir fisheries, and 16% (50,485 pounds) to rivers other than tailwaters.

The Blue Ridge physiographic province of eastern Tennessee contains about 1,000 km (621 mi) of coldwater streams inhabited by wild (self-sustaining) populations of Rainbow Trout *Oncorhynchus mykiss*, Brook Trout *Salvelinus fontinalis*, and Brown Trout *Salmo trutta*. Wild trout occur in 9 of Region IV's 21 counties (primarily those that border North Carolina; Figure 1-1). The Tennessee portion of Great Smoky Mountains National Park (GSMNP) in Cocke, Sevier, and Blount counties contains another 395 km (245 mi) of wild trout streams. Most of Region IV's wild trout resource outside GSMNP is located within the U.S. Forest Service's (USFS) 253,000-hectare (625,000-acre) Cherokee National Forest (CNF). However, a substantial portion (~30%) occurs on privately owned lands and includes some of the State's best wild trout streams.

Rainbow Trout, native to Pacific-drainage streams of the western U.S., and Brown Trout, native to Europe, were widely introduced into coldwater habitats during the past century and have become naturalized in many Tennessee streams. Brook Trout are Tennessee's only native salmonid and once occurred at elevations as low as 490 m (1,600 ft.) in some streams (King 1937). They currently occupy about 223 km (139 mi) in 109 streams, or about 24% of the stream length supporting wild trout outside GSMNP. Brook Trout occur allopatrically (no other trout species are present) in 42 streams totaling 72 km (45 mi.), representing 32% of the Brook Trout resource. Another 13 streams have waterfalls or man-made barriers that maintain Brook Trout allopatry in most of the 37 km (23 mi.) of habitat they provide.

Wild trout populations reflect the quality and stability of the aquatic systems they inhabit, as well as associated terrestrial systems. TWRA recognizes the ecological importance of Tennessee's wild trout resources (particularly native Brook Trout), their value to anglers, and the special management opportunities they offer. The Agency's current statewide trout management plan (TWRA 2017) features management goals and strategies designed to conserve wild trout and their habitat while providing a variety of angling experiences.

Many streams with unregulated flows can support trout fisheries, but are limited by marginal summer habitat or levels of natural production insufficient to meet existing fishing pressure. TWRA provides or supplements trout fisheries in 34 such streams in Region IV by annually stocking hatchery-produced (adult) Rainbow Trout. Some stocked steams (e.g., Beaverdam Creek, Doe Creek, Laurel Fork, and Doe River) do support excellent wild trout populations as well, but the moderate stocking rates employed are considered to pose no population-level problems for the resident fish (Meyer et al. 2012).

Cold, hypolimnetic releases from five Tennessee Valley Authority (TVA) dams in Region IV (Norris, Ft. Patrick Henry, South Holston, Wilbur, and Boone) also support year-round trout fisheries in the tailwaters downstream (Figure 1-1). The habitat and food resources that characterize these tailwaters provide for higher carrying capacities and allow trout to grow larger than they normally do in other streams. Tailwaters are typically stocked with fingerlings (~102 mm) in the early spring and adult fish (229-305 mm) throughout the summer. Stocked adult trout supplement the catch during peak angling season and by fall, fingerlings have begun to enter these fisheries, meaning they are a catchable size. Recruitment of natural reproduction (mostly by Brown Trout) contributes substantially to the fisheries in the South Holston and Wilbur (Watauga River) tailwaters. Recent surveys have indicated the presence of natural reproduction by Rainbow Trout in the Norris and South Holston tailwaters, but it is unknown if this is providing any significant contribution to the fishery. The Holston River below Cherokee Reservoir (Figure 1-1) also supports a tailwater trout fishery, although high water temperatures (>21° C) during late summer and early fall may limit survival. No fingerlings are stocked there, as few would survive the thermal bottleneck to recruit to the fishery. More research is needed to determine what fish are contributing to the fishery in our tailwaters.

Reservoirs that stratify during summer months but have habitat suitable for trout below depths normally occupied by warmwater species are termed 'two-story' fisheries. These reservoirs must have a zone with water below 21° C and a minimum dissolved oxygen concentration of 3.0 mg/L (Wilkins et al. 1967). Seven two-story reservoirs in Region IV (Calderwood, Chilhowee, Tellico, Ft. Patrick Henry, South Holston, Wilbur, and Watauga) have such zones and create an additional trout resource (Figure 1-1). These reservoirs are stocked with adult Rainbow Trout during the late fall and winter when reservoir temperatures are uniformly cold and piscivorous warmwater predators are less active. Watauga and South Holston reservoirs are also annually stocked with sub-adult Brown Trout and Lake Trout *Salvelinus namaycush*, and excellent Lake Trout fisheries have developed in these two reservoirs.

One of TWRA's core functions identified in its Strategic Plan (TWRA 2014) is outdoor recreation, and a primary objective is to maintain or improve programs that promote high user satisfaction for hunters, anglers, and boaters. Tennessee's trout anglers recently expressed a high level of satisfaction (89%) with the Agency's management of the State's trout fisheries (Schexnayder et al. 2014). Maintaining this level of satisfaction will require effective management of existing resources and opportunities—as well as development of new ones. TWRA's new statewide trout management plan for the next 10 years (TWRA 2017) addresses how these goals can be accomplished. This plan includes management guidelines for Tennessee's native Brook Trout, particularly in light of new genetics data being acquired for all Brook Trout populations. Acquisition of trout population status and dynamics data from streams and tailwaters through standardized stream survey techniques (e.g., abundance trends and size structures, etc.) will also continue to be an important strategy for managing these fisheries.

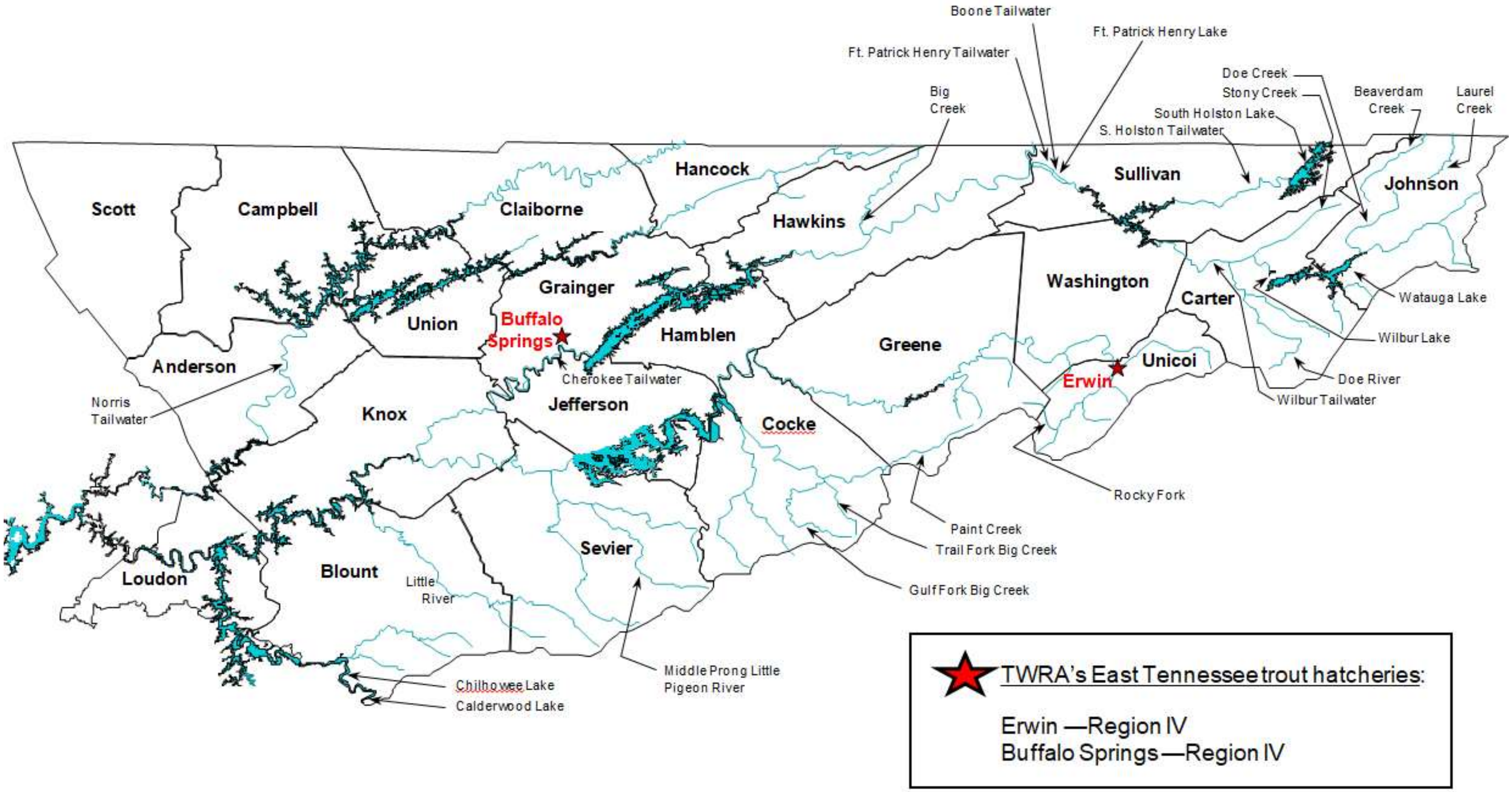


Figure 1-1. Locations of selected Region IV trout fisheries managed by TWRA.

2. WILD TROUT STREAM ACCOUNTS

Six trout streams were quantitatively sampled during 2018 field season (June-October) within Region IV. Overall, trout abundance remained below long term averages. This is likely associated with the abnormally dry to extreme drought condition in the Tennessee River watershed, particularly in eastern Tennessee, during May 2016 to mid-April 2017 according to United States Drought Monitor. Drought throughout the region decreases base stream flow and increases temperatures, which can limit adult recruitment and affect the overall health of trout. Since then, Region 4 has been drought free and trout biomass should start to increase in 2019 given more normal flow conditions.

Individual accounts for all wild trout streams sampling during 2018 are provided below. A list of all streams sampling quantitatively during 1991-2018 is provided in Appendix A.

2.1 SAMPLING METHODS

Wild trout stream sampling was conducted with battery-powered backpack electrofishing units employing inverters to produce AC outputs. Output voltages were 125-600 VAC, depending upon water conductivity. All quantitative (three-pass depletion) sampling followed TWRA's standard protocols (TWRA 1998). Three-pass depletion sampling provides accurate trout abundance estimates in typical southern Appalachian streams (Habera et al. 2010), is endorsed by the Southern Division, American Fisheries Society's (SDAFS) Trout Committee, and is widely used by other state and federal agencies in the region. Stocked Rainbow Trout, distinguishable by dull coloration, eroded fins, atypical body proportions, and large size (usually >229 mm), compared to wild Rainbow Trout were noted on data sheets but were not included in any analyses. A list of the common and scientific names of all fish collected during 2018 sampling efforts in wild trout streams is provided in Table 2-1.

Removal-depletion data were analyzed with MicroFish 4.0 for Windows (http://microfish.org/) developed by Jack Van Deventer in cooperation with the SDAFS Trout Committee. Trout ≤90 mm in length were analyzed separately from those >90 mm. Trout in the smaller size group tend to have lower catchabilities (Lohr and West 1992; Thompson and Rahel 1996; Peterson et al. 2004; Habera et al. 2010), making separate analysis necessary to avoid bias. These two groups also roughly correspond to young-of-the-year (YOY or age-0) and adults.

Table 2-1. Common and scientific names of fishes collected during 2018 quantitative trout stream surveys[1].

Common Name	Scientific Name
Minnows	Cyprinidae
Central Stoneroller	*Campostoma anomalum*
Warpaint Shiner	*Luxilus coccogenis*
River Chub	*Nocomis micropogon*
Saffron Shiner	*Notropis rubricroceus*
Blacknose Dace	*Rhinichthys atratulus*
Creek Chub	*Semotilus atromaculatus*
Suckers	Catostomidae
White Sucker	*Catostomus commersonii*
Northern Hogsucker	*Hypentelium nigricans*
Trouts	Salmonidae
Rainbow Trout	*Oncorhynchus mykiss*
Brown Trout	*Salmo trutta*
Brook Trout	*Salvelinus fontinalis*
Sculpins	Cottidae
Mottled Sculpin	*Cottus bairdii*
Sunfishes	Centrarchidae
Rockbass	*Ambloplites rupestris*
Green Sunfish	*Lepomis cyanellus*
Bluegill	*L. macrochirus*
Black Basses	
Smallmouth Bass	*Micropterus dolomieu*
Largemouth Bass	*M. salomoides*
Perches	Percidae
Greenfin Darter	*Etheostoma chlorobranchium*
Fantail Darter	*E. flabellare*
Snubnose Darter	*E. simoterum*
Swannanoa Darter	*E. swannanoa*

[1]Nomenclature follows Page et al. (2013).

2.2 BEAVERDAM CREEK

Beaverdam Creek is one of Tennessee’s best-known wild trout streams and is on an annual monitoring schedule, but it was not sampled in 2018 because of frequent high flows in late August and September. This was the first year since annual monitoring began in 1991 that Beaverdam was not sampled.

Beaverdam Creek was selected as one of several wild trout streams to be screened in 2018 for *Myxobolus cerebralis*, the causative parasite for Whirling Disease. Sixty fingerling Rainbow Trout were collected from throughout the stream in July and shipped to the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University for analysis using nested PCR tests and digest/microscopic examinations for myxospores. Results were negative.

2.3 DOE CREEK

Study Area

Doe Creek is a large spring-fed tributary to Watauga Reservoir in Johnson County. It flows through privately-owned land, much of which is being used for agricultural and residential purposes. Doe Creek is probably best known for the trophy Rainbow Trout fishery it supported during the 1950s and 1960s. That fishery consisted of an annual run of fall-spawning Rainbow Trout from Watauga Reservoir and probably originated from eggs planted at the mouth of the stream in 1954 (Bivens et al. 1998). Although the trophy fishery disappeared in the early 1970s, Doe Creek still supports one of Tennessee's finest populations of wild Rainbow Trout and some large (>500 mm) Rainbow Trout still enter Doe Creek each winter from the lake. Adult Rainbow Trout are also stocked during March-June (about 2,800/year) and general (statewide) trout fishing regulations apply.

Doe Creek was originally surveyed by Shields (1950) and later qualitatively sampled by Bivens (1989). Ironically, Shields (1950) recommended removal of Doe Creek from the trout stream list because of its limited trout carrying capacity and lack of potential for reproduction at that time. A 2003 creel survey indicated that Doe Creek had the highest estimated trout catch and harvest rates among the five streams surveyed and was second only to Doe River (primarily in Roan Mountain State Park) in terms of estimated angler effort for trout (Habera et al. 2004).

The current long-term monitoring station on Doe Creek was established in 1993 and has been sampled annually since then. It is located along Highway 67 and ends at the old dam just below the confluence with the outflow from Lowe Spring, which is an important source of cold water for Doe Creek. Sample site location and effort details, along with habitat and water quality information are given in Table 2-2.

Results and Discussion

Catch data and abundance estimates for all species sampled at the Doe Creek station in 2018 are given in Table 2-3. Estimated Rainbow Trout density has decreased each year since 2014 and is below the long-term average (Figure 2-1). Trout biomass has also decreased each year since 2014, however there was little change from last year (Figure 2-1). Doe Creek previously produced wild Rainbow Trout biomass estimates >100 kg/ha (1993, 1997, and 2004) and averaged 75 kg/ha prior to 2007 (Figure 2-1). However, wild trout production in Doe Creek is not typically attaining this former level. Biomass has averaged just below 60 kg/ha since 2007 and 2018 abundance estimates ranked among the lowest obtained since monitoring began in 1993. This decline may be a result of drought conditions over the past few years. However, this past year was one of the wettest on history, thus abundance should start to increase with increasing water quantity and quality.

The Rainbow Trout cohort was not a strong as previous years with only 34% (n = 42) of the 134 Rainbow Trout captured were 70-110 mm (age 0). Age-1 fish largely appear in the 127-178 mm size classes in the length frequency histogram (Figure 2-2) and appear to be relatively consistent with 2017, which like likely due to the large age-0 size class last year. Recruitment into the larger (≥203 mm) adult size classes (10 fish; Figure 2-2) is higher than last year (4 fish), including two trout ≥229 mm. With improved habitat conditions in 2018 (higher flow and lower temperature) and more large fish compared to 2017, increased biomass and density could be expected next year.

Doe Creek was selected as one of several wild trout streams to be screened in 2018 for *Myxobolus cerebralis*, the causative parasite for Whirling Disease. Sixty fingerling Rainbow Trout were collected from throughout the stream in July and shipped to the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University for analysis using nested PCR tests and digest/microscopic examinations for myxospores. Results were negative.

Management Recommendations

Doe Creek remains one of Tennessee's most productive wild trout streams and TWRA is committed to maintaining it. The seasonal hatchery-supported trout fishery in Doe Creek is popular (Habera et al. 2004), but management of this stream should feature the outstanding wild trout population. The current stocking program is not incompatible with wild trout management or native fish assemblages (Weaver and Kwak 2013), but it should not be expanded in scope or scale. Annual monitoring at the station near Lowe Spring should continue and may help identify any impacts related to Mountain City's water withdrawals (0.5 million gallons per day) from the spring, which began in 2002. Additionally, a new angler survey would help determine if current stocking levels are appropriate.

Table 2-2. Site and sampling information for Doe Creek in 2018.

Location	Station 1	
Site code	420182601	
Sample date	29 August	
Watershed	Watauga River	
County	Johnson	
Quadrangle	Doe 214 NW	
Lat-Long	36.42709 N, -81.93725 W	
Reach number	06010103-37,0	
Elevation (ft)	2,210	
Stream order	4	
Land ownership	Private	
Fishing access	Good	
Description	Site ends at small dam just below Lowe spring.	
Effort		
Station length (m)	134	
Sample area (m^2)	1005	
Personnel	11	
Electrofishing units	3	
Voltage (AC)	125	
Removal passes	3	
Habitat		
Mean width (m)	7.5	
Maximum depth (cm)	64	
Canopy cover (%)	45	
Aquatic vegetation	scarce	
Estimated % of site in pools	37	
Estimated % of site in riffles	63	
Habitat assessment score	155 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	
Sand	5	5
Gravel	25	25
Rubble	20	35
Boulder	20	25
Bedrock	25	10
Water Quality		
Flow (cfs; visual)	23.4; normal	
Temperature (C)	16.6	
pH	7.4	
Conductivity (µS/cm)	151	
Dissolved oxygen (mg/L)	N/M	
Alkalinity (mg/L $CaCO_3$)	70	

Table 2-3. Fish population abundance estimates (with 95% confidence limits) for the monitoring station on Doe Creek sampled 29 August 2018.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Weight (g)	Mean Fish Wt. (g)	Biomass (kg/ha) Est.	Biomass (kg/ha) Lower C.L.	Biomass (kg/ha) Upper C.L.	Density (fish/ha) Est.	Density (fish/ha) Lower C.L.	Density (fish/ha) Upper C.L.
RBT ≤90 mm	1	1	1	1	7	7.0	0.07	0.07	0.07	10	10	10
RBT >90 mm	122	127	122	134	4,068	32.0	40.48	38.85	42.67	1,264	1,214	1,333
Creek Chub	3	5	5	45	13	2.7	0.13	0.13	1.21	50	50	448
Blacknose Dace	107	111	107	118	361	3.3	3.59	3.46	3.82	1,104	1,065	1,174
Fantail Darter	38	52	38	80	101	1.9	1.01	0.74	1.55	517	378	796
Mottled Sculpin	284	426	284	1803	309	0.7	3.07	2.05	13.01	4,239	2,826	17,940
C. Stoneroller	112	117	112	124	1,174	10.0	11.68	11.18	12.38	1,164	1,114	1,234
N. Hogsucker	2	2	2	38	2	0.9	0.02	0.02	0.32	20	20	378
Snubnose Darter	1	1	1	1	1	1.0	0.01	0.01	0.01	10	10	10
Totals	**670**	**842**	**672**	**2,344**	**6,036**		**60.06**	**56.51**	**75.04**	**8,378**	**6,687**	**23,323**

Note: RBT = Rainbow Trout.

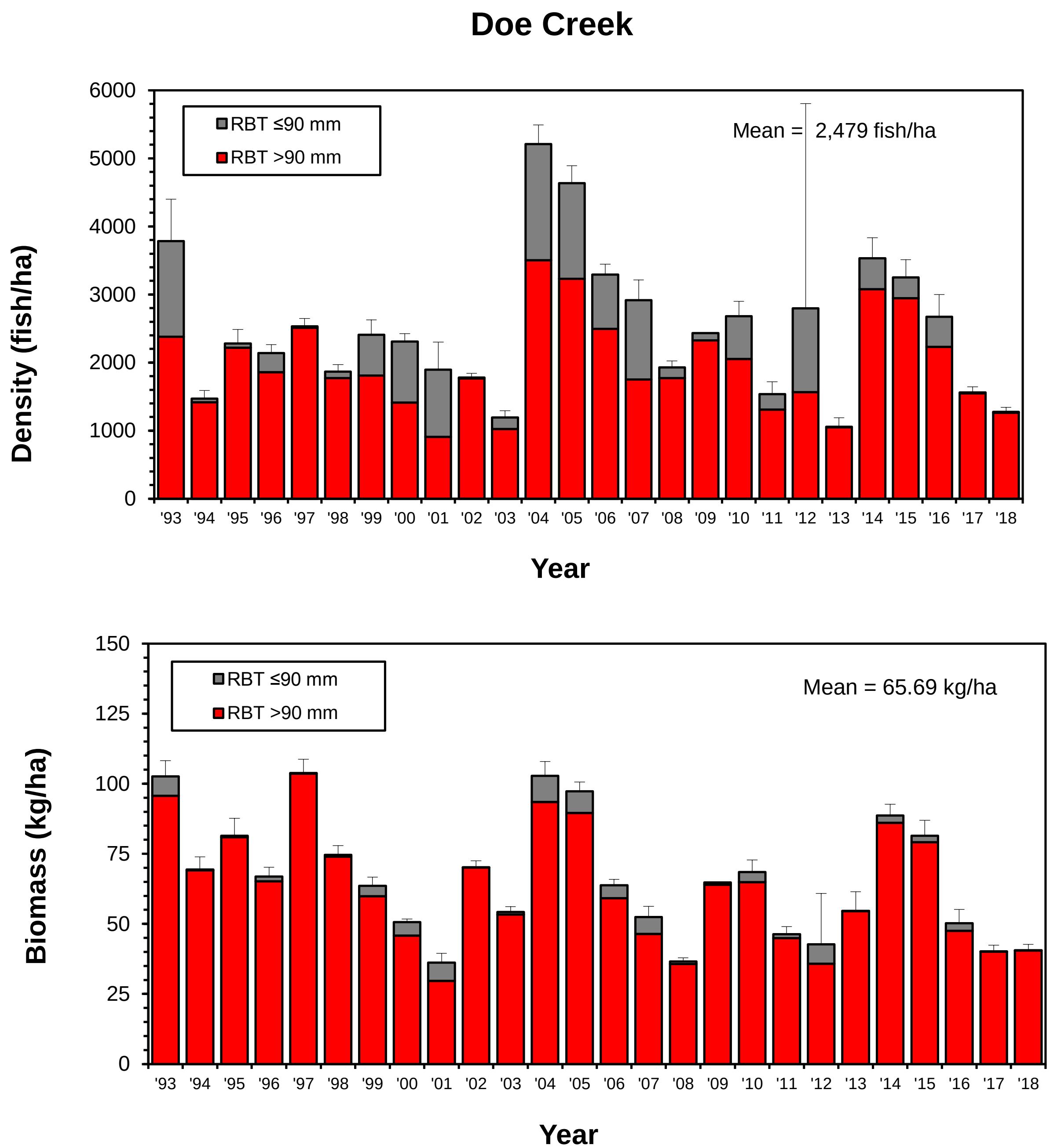


Figure 2-1. Trout abundance estimates for the Doe Creek monitoring station. RBT = Rainbow Trout. Bars indicate upper 95% confidence limits (total).

Doe Creek

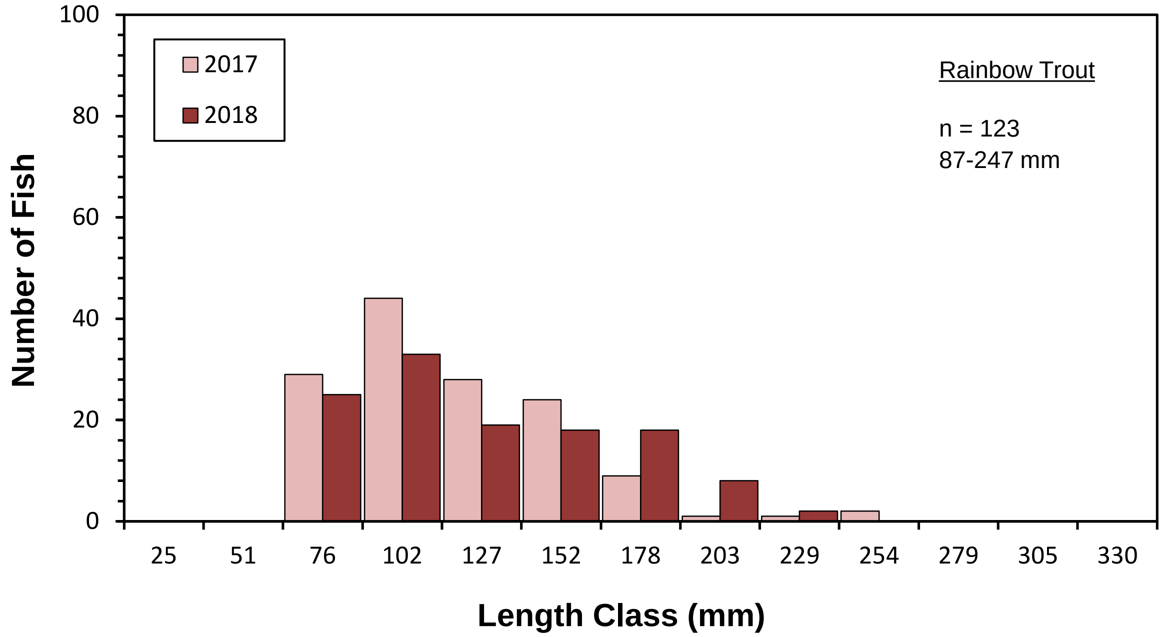


Figure 2-2. Length frequency distribution for Rainbow Trout from the 2017 and 2018 Doe Creek sample.

2.4 DOE RIVER

Study Area

Doe River originates on Iron Mountain in Carter Count and flows through forested, residential, and agricultural areas to its confluence with the Watauga River in Elizabethton. Part of the headwater area lies within the CNF and the stream also flows through Roan Mountain State Park. The upper 2.8 km of Doe River previously supported a mixed population of native Brook Trout and Rainbow Trout beginning in 909 m (2,980') elevation (Strange and Habera 1997). However, a 2003 qualitative survey of the monitoring station near the Cove Creek confluence (3,250') produced only one Brook Trout (Habera et al. 2004) and none were located in 2007 (Habera et al. 2008) or 2015 (Habera et al. 2016). Although the main stem of upper Doe River (upstream of Roan Mountain State Park) has lost its Brook Trout population, seven tributaries in this area still provide 8.5 km of native Brook Trout habitat. Between Cove Creek and the town of Roan Mountain, Doe River supports some of Tennessee's finest populations of wild Rainbow and Brown trout. Interestingly, Shields, (1950) observed that this part of Doe River could provide a hatchery-supported trout fishery, but was not capable of producing many trout on its own.

TWRA continues to maintain a put-and-take fishery for stocked Rainbow Trout in the Doe River, primarily to help meet angler demand in the Roan Mountain State Park vicinity. About 8,500 catchable Rainbow Trout are stocked in this area each year during March-June. The entire stream is subject to general trout angling regulations. A roving creel survey conducted in 2003 (Habera et al. 2004) documented the importance of the wild and stocked trout fisheries in Doe River, as it had the highest estimated angler effort for trout (459 h/ha) and highest estimated total trout catch (2,002) among the five streams studied (Beaverdam Creek, Laurel Creek, Doe Creek, Doe River, and Stony Creek). Additionally, estimated trout harvest (354) and total trout catch rate (0.29 fish/h) for Doe River in 2003 were only surpassed by those for Doe Creek (Habera et al. 2004).

A sample site was established downstream of Roan Mountain State Park in 1996 to document wild trout abundance in Doe River (Bivens et al. 1997; Strange and Habera 1997). This site was sampled again in 1998 to assess the effects of the severe flood that occurred in the Doe River watershed in January of that year (Habera et al. 1999) and was later added to the monitoring stream rotation for the three years beginning in 2002. In addition to the monitoring station in the Brook/Rainbow Trout sympatric zone mentioned above (sampled during 1995-1999), one other quantitative sampled was obtained upstream of the State Park (3,070') in 1995 (Strange and Habera 1996). Site location and effort details for the 2018 sample, along with habitat and water quality information, are summarized in Table 2-4.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Doe River station in 2018 are given in Table 2-5. Total trout abundance estimates (Figure 2-4) were the lowest since 1998 (density) and 1996 (biomass). Declines in the number of age-1 fish (100-170 mm) trout (both species) compared to the 2015 sample primarily contributed to these low abundances. There were also fewer Brown Trout >300 mm in 2018 (n = 1) compared to the 2015 sample (n = 4). Although abundance was down, the size structures of each population appeared to be relatively well balanced.

Doe River was selected as one of several wild trout streams to be screened in 2018 for *Myxobolus cerebralis*, the causative parasite for Whirling Disease. Sixty fingerling Rainbow Trout were collected from throughout the stream in July and shipped to the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University for analysis using nested PCR tests and digest/microscopic examinations for myxospores. Results were positive, but no fish were found to have clinical signs of Whirling Disease, meaning the pathogen is present, but there is no evidence of disease. It is not thought that the decrease in abundance of Rainbow and Brown trout in this site is due to the presence of *M. cerabralis*; many of the streams monitored this year have relatively low trout abundance, likely due to drought conditions in recent years.

Management Recommendations

Doe River supports an outstanding fishery for wild Rainbow and Brown Trout that future management should emphasize. The hatchery supported trout fishery in Doe River is also very popular, as 74 % anglers surveyed in 2003 approved of stocking the stream. The current level of stocking with catchable-size Rainbow Trout is not incompatible with the wild trout management or native fish assemblages (Waver and Kwak 2013). A new Delayed Harvest fishery (November through last day of February) was established in Doe River within Roan Mountain State Park in 2018. A total of 1,625 Rainbow Trout were stocked for this fishery during fall 2018 and January 2019.

Trout Unlimited and the City of Roan Mountain have also requested additional stocking in a downstream area that is currently not stocked. They are working on private land access agreements to develop a fishing trail along this portion of the Doe River. This area is bounded by the Hwy. 19E (36.205815, -82.105594) and Holly Hill Road (36.230776, -82.144299) crossings. Currently, the trout population status in this section of Doe River is unknown, but it is likely some wild Rainbow Trout and Brown Trout are present. Trout Unlimited requested that adult Rainbow Trout be stocked in this section during March-May beginning in 2020 in conjunction with the current March-June Doe River stocking. Water temperatures in this downstream section may be too warm for trout in late May and June.

It is recommended that sampling of the Doe River monitoring station continue at three-year intervals to further develop the database for this valuable resource and assess any impacts of *M. cerebralis*.

Table 2-3. Site and sampling information for Doe River in 2018.

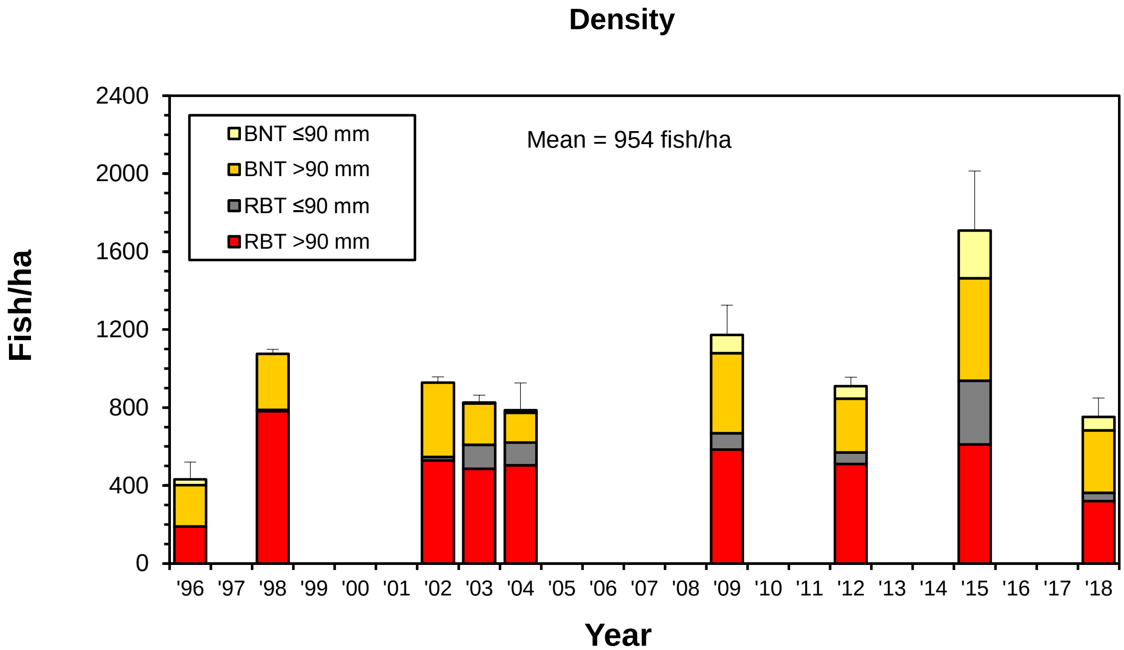
Location	**Station 1**	
Site code	420182501	
Sample date	28 August	
Watershed	Watauga River	
County	Carter	
Quadrangle	White Rocks Mtn. 2084 NE	
Lat-Long	36.18243 N, 82.07546 W	
Reach number	06010103-50,0	
Elevation (ft)	2,640	
Stream order	4	
Land ownership	Private	
Fishing access	Good	
Description	Site begins just upstream of garage at parking area upstream of bridge at Xmas tree farm (near Roan Mountain State Park boundary.	
Effort		
Station length (m)	196	
Sample area (m²)	2156	
Personnel	16	
Electrofishing units	4	
Voltage (AC)	250	
Removal passes	3	
Habitat		
Mean width (m)	11.0	
Maximum depth (cm)	180	
Canopy cover (%)	40	
Aquatic vegetation	scarce	
Estimated % of site in pools	60	
Estimated % of site in riffles	40	
Habitat assessment score	154 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt		
Sand	15	10
Gravel	15	20
Rubble	35	50
Boulder	15	10
Bedrock	20	10
Water Quality		
Flow (cfs; visual)	24.22; normal	
Temperature (C)	19.7	
pH	7.2	
Conductivity (µS/cm)	68	
Dissolved oxygen (mg/L)	N/M	
Alkalinity (mg/L $CaCO_3$)	40	

Table 2-4. Fish population abundance estimates (95% confidence limits) for the monitoring station on Doe River sampled 28 August 2018.

		Population Size			Est.	Mean	Biomass (kg/ha)			Density (fish/ha)		
	Total		Lower	Upper	Weight	Fish Wt.		Lower	Upper		Lower	Upper
Species	Catch	Est.	C.L.	C.L.	(g)	(g)	Est.	C.L.	C.L.	Est.	C.L.	C.L.
RBT ≤90 mm	9	9	4	14	77	8.6	0.36	0.16	0.56	42	19	65
RBT >90 mm	68	69	66	72	4,111	59.6	19.07	18.24	19.90	320	306	334
BNT ≤90 mm	14	15	8	22	126	8.4	0.58	0.31	0.86	70	37	102
BNT >90 mm	66	69	63	75	3,312	48.0	15.36	14.03	16.70	320	292	348
Smallmouth Bass	11	11	8	14	1,386	126.0	6.43	4.68	8.18	51	37	65
Green Sunfish	2	2	2	2	158	79.0	0.73	0.73	0.73	9	9	9
Rock Bass	2	2	2	2	158	79.0	0.73	0.73	0.73	9	9	9
River Chub	421	505	461	549	4,923	9.7	22.83	20.74	24.70	2,342	2,138	2,546
Blacknose Dace	57	94	29	159	294	3.1	1.36	0.42	2.29	436	135	737
Fantail Darter	93	139	93	922	266	1.9	1.23	0.82	8.13	645	431	4,276
Greenfin Darter	2	2	2	38	24	2.0	0.11	0.02	0.35	9	9	176
Snubnose Darter	1	1	1	1	1	1.0	0.00	0.00	0.00	5	5	5
Swannanoa Darter	7	11	7	40	77	7.0	0.36	0.23	1.30	51	32	186
Saffron Shiner	511	779	638	920	1,486	1.9	6.89	5.62	8.11	3,613	2,959	4,267
Warpaint Shiner	59	90	39	141	580	6.4	2.69	1.16	4.19	417	181	654
Stoneroller	190	209	193	225	3,414	16.3	15.83	14.59	17.01	969	895	1,044
N. Hog Sucker	86	108	81	135	2,986	27.7	13.85	10.41	17.34	501	376	626
White Sucker	1	1	1	1	32	32.0	0.15	0.15	0.15	5	5	5
Totals	**1,600**	**2,116**	**--**	**--**	**23,411**		**108.59**	**--**	**--**	**9,814**	**--**	**--**

Note: RBT = Rainbow Trout and BNT = Brown Trout.

Doe River



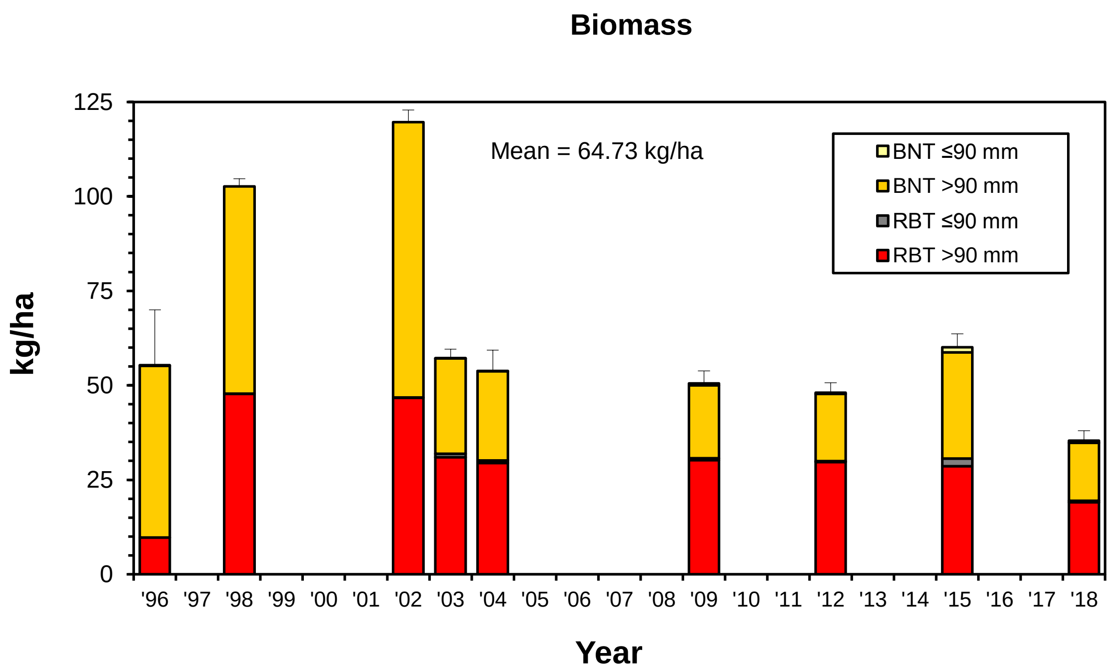
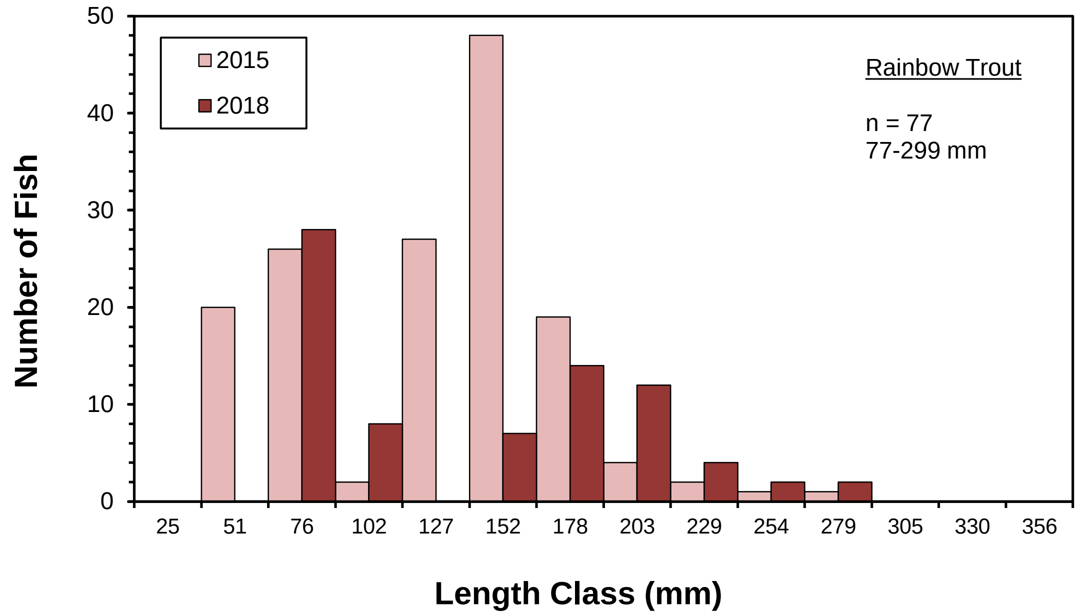


Figure 2-3. Trout abundance estimates for the Doe River monitoring station. RBT = Rainbow Trout and BNT = Brown Trout. Error bars indicate upper 95% confidence limits (total).

Doe River



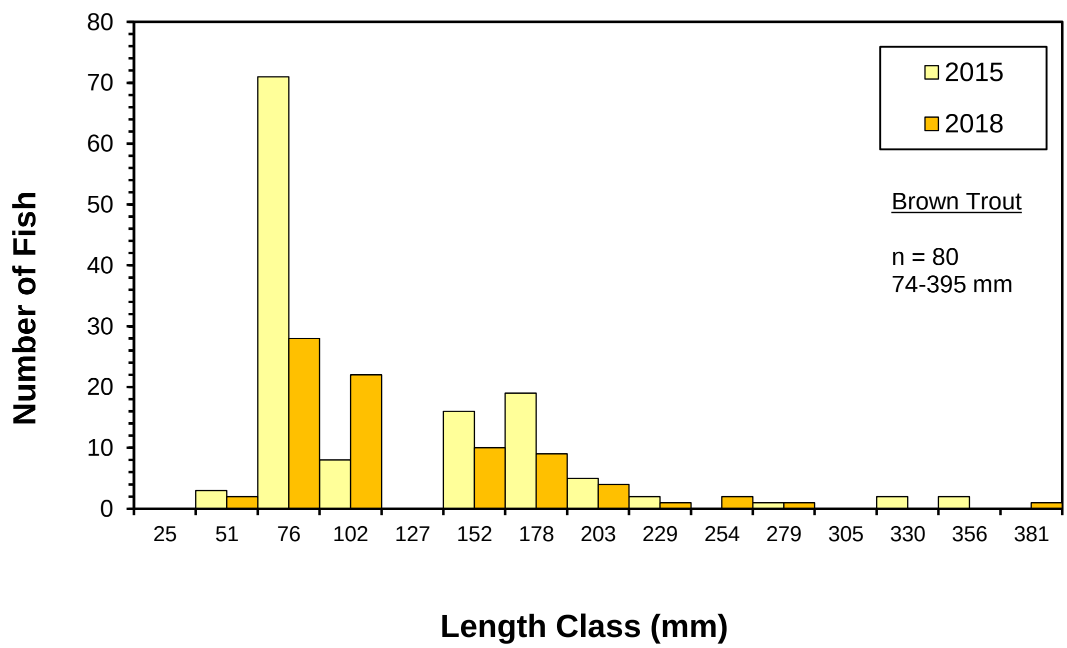


Figure 2-4. Length frequency distributions for Rainbow and Brown Trout from the 2015 and 2018 Doe River samples.

2.5 LAUREL FORK

Study Area

Laurel Fork flows through a mountainous, forested watershed (mostly within the CNF) in Carter County and is a tributary to the Doe and Watauga rivers. Most of the upper portion of the stream is low gradient (<5%) despite elevations above 915 m (3,000'). Laurel Fork is one of the few Tennessee streams where wild Brown Trout dominate. The upper portion of Laurel Fork and nine of its tributaries currently support Brook Trout. Four other tributaries (Lacy Trap, Bunton, Cook, and Cherry Flats branches) had 3.5 km of Brook Trout habitat in the 1990s, but these populations were not found during distribution surveys in 2012-2013. Among the remaining populations, only Leonard Branch is known to have native Brook Trout (Strange and Habera 1997).

Shields (1950) made no reference to Brown Trout in his discussion of Laurel Fork, mentioning only a fishery for stocked Rainbow Trout. Agency records indicate Brown Trout were first stocked in Laurel Fork in 1951 and heavily during the 1950s and 1960s. By 1979, Brown Trout were present throughout the stream segment on the CNF, along with stocked Rainbow Trout (Bivens 1984). Management as a put-and-take Rainbow Trout fishery continued until 1988, when wild trout regulations were established on the upper portion of the stream. A three-fish creel limit was added to the 229-mm minimum size limit and single-hook regulation already in place. Stocking was discontinued except in the Dennis Cove area, where about 3,700 adult Rainbow Trout are stocked March-June each year. Laurel Fork was included in the wild trout streams placed under more biologically-based angling regulations in 2013, including a five-fish creel limit and no minimum size limit. Abundance, growth, production, and movement of wild Brown and Brook Trout in upper Laurel Fork were documented by Strange et al. (2000).

Previously, Bivens (1988) and Bivens and Williams (1990) qualitatively sampled Laurel Fork for TWRA. Monitoring stations were established in 1991 and sampled annually through 2000 (Habera et al. 2001a). These monitoring stations were rotated back on the sampling schedule in 2003 have been sampled at three-year intervals since then. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-6.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Laurel Fork stations in 2018 are given in Table 2-7. Abundance estimates continued to decline at Station 1 trend started in 2006 and were the lowest obtained to date at 30-35% of the long-term means for Station 1 (450 fish/ha and 18.1 kg/ha; Figure). The low abundance estimates in Station 1 are likely due to the small age-0 age class and overall low trout numbers within the station. Although, there were more large Brown Trout ≥ 229 mm (7) compared to 2015 (2); there was an overall lower number of trout this year (n = 24) compared to 2015 (n = 64). Station 2 had a fish density of 382 fish/ha compared to the long-term average of 477 fish/ha and a biomass of 23.5 kg/ha compared to the long-term average of 24.6 kg/ha; both abundance estimates just below the long term averages. Although, the total number of trout captured in 2018 was less than 2015, all size classes were represented well, with more large Brown Trout ≥ 229 mm in 2018 (13) compared to 2015 (5). This increase in large Brown Trout is likely what is driving the higher biomass in 2018 compared to 2015. Adult and young of year Brook Trout were also found in Station 2 for the first time since 2009. Rainbow Trout and Brook Trout were common in this station in the 1990's, however Brown

Trout have become the dominant species, with no Rainbow Trout found since 2000, and few Brook Trout found since then. All year classes are well represented in Station 2 for Brown Trout and the trout population is healthy in Station 2, however the small age-0 year class in Station 1 is concerning. Station 1 should be able to recover this small year class next year because of it large number of adult Brown Trout.

Management Suggestions

Laurel Fork's wild Brown Trout fishery makes it a valuable and relatively unique Tennessee resource that TWRA's management should feature. Accordingly, while the existing Rainbow Trout stocking program is not incompatible with wild trout management or native fish assemblages (Weaver and Kwak 2013), there should be no expansion in terms of numbers or area involved. Laurel Fork is on a sampling rotation of every third year, which will permit continued development of a database for this important fishery.

Table 2-6. Site and sampling information for Laurel Fork in 2018.

Location	Station 1		Station 2	
Site code	420182701		420182702	
Sample date	05 September		14 September	
Watershed	Watauga River		Watauga River	
County	Carter		Carter	
Quadrangle	Watauga Dam 207 SE		White Rocks Mtn. 208 NE	
Lat-Long	36.25611N-82.10306W		36.23972N-82.08056W	
Reach number	06010103-17,0		06010103-17,0	
Elevation (ft)	2,660		2,880	
Stream order	4		3	
Land ownership	USFS		USFS	
Fishing access	Good		Good	
Description	Begins at trail crossing 3 upstream of the end of the gated USFS access road.		Begins ~300 m above the mouth of Leonard Br. at a large campsite	
Effort				
Station length (m)	180		236	
Sample area (m²)	1,777		1,935	
Personnel	12		13	
Electrofishing units	3		3	
Voltage (AC)	450		400	
Removal passes	3		3	
Habitat				
Mean width (m)	9.9		8.2	
Maximum depth (cm)	98		NM	
Canopy cover (%)	85		75	
Aquatic vegetation	scarce		scarce	
Estimated % of site in pools	49		60	
Estimated % of site in riffles	51		40	
Habitat assessment score	162 (optimal)		160 (sub-optimal)	
Substrate Composition	Pool (%)	Riffle (%)	Pool (%)	Riffle (%)
Silt	5	0	20	0
Sand	15	15	25	25
Gravel	15	15	20	25
Rubble	15	35	10	30
Boulder	15	35	15	15
Bedrock	35	0	10	5
Water Quality				
Flow (cfs; visual)	27.82; high		12.94; normal	
Temperature (C)	18.4		17.4	
pH	6.8		7.0	
Conductivity (µS/cm)	37.5		44	
Dissolved oxygen (mg/L)	NM		NM	
Alkalinity (mg/L $CaCO_3$)	15		15	

Table 2-7. Fish population abundance estimates (with 95% confidence limits) for two stations on Laurel Fork sampled 5 and 14 September 2018.

		Population Size			Est.	Mean	Biomass (kg/ha)			Density (fish/ha)		
	Total		Lower	Upper	Weight	Fish Wt.		Lower	Upper		Lower	Upper
Species	Catch	Est.	C.L.	C.L.	(g)	(g)	Est.	C.L.	C.L.	Est.	C.L.	C.L.
Station 1												
BNT ≤90 mm	0	--	--	--	--	--	0.00	--	--	0	--	--
BNT >90 mm	24	25	24	30	1,748	112.0	9.84	9.84	18.91	141	135	169
Creek Chub	20	69	20	360	462	6.7	2.60	0.75	13.57	388	113	2,026
W. Blacknose Dace	121	134	121	148	482	3.6	2.71	2.45	3.00	754	681	833
Totals	**165**	**228**	**165**	**538**	**2,693**	**122**	**15.15**	**19.00**	**35.48**	**1,283**	**929**	**3,028**
Station 2												
BNT ≤90 mm	16	17	16	23	89	5.2	0.46	0.43	0.62	88	83	119
BNT >90 mm	54	55	54	59	4,369	79.4	22.58	22.16	24.21	284	279	305
BKT ≤90 mm	1	1	1	1	4	4.0	0.02	0.02	0.02	5	5	5
BKT >90 mm	1	1	1	1	87	87.0	0.45	0.45	0.45	5	5	5
Bluegill	7	7	7	13	118	16.8	0.61	0.61	1.13	36	36	67
Creek Chub	173	201	177	225	1,246	6.2	6.44	5.67	7.21	1,039	915	1,163
Largemouth Bass	1	1	1	1	12	12.0	0.06	0.06	0.06	5	5	5
W. Blacknose Dace	165	214	172	256	728	3.4	3.76	3.02	4.50	1,106	889	1,323
White Sucker	38	39	38	44	1,868	47.9	9.65	9.41	10.89	202	196	227
Totals	**456**	**536**	**467**	**623**	**8,521**		**43.35**	**40.85**	**49.09**	**2,770**	**2,413**	**3,220**

Note: BNT = Brown Trout; BKT = Brook Trout

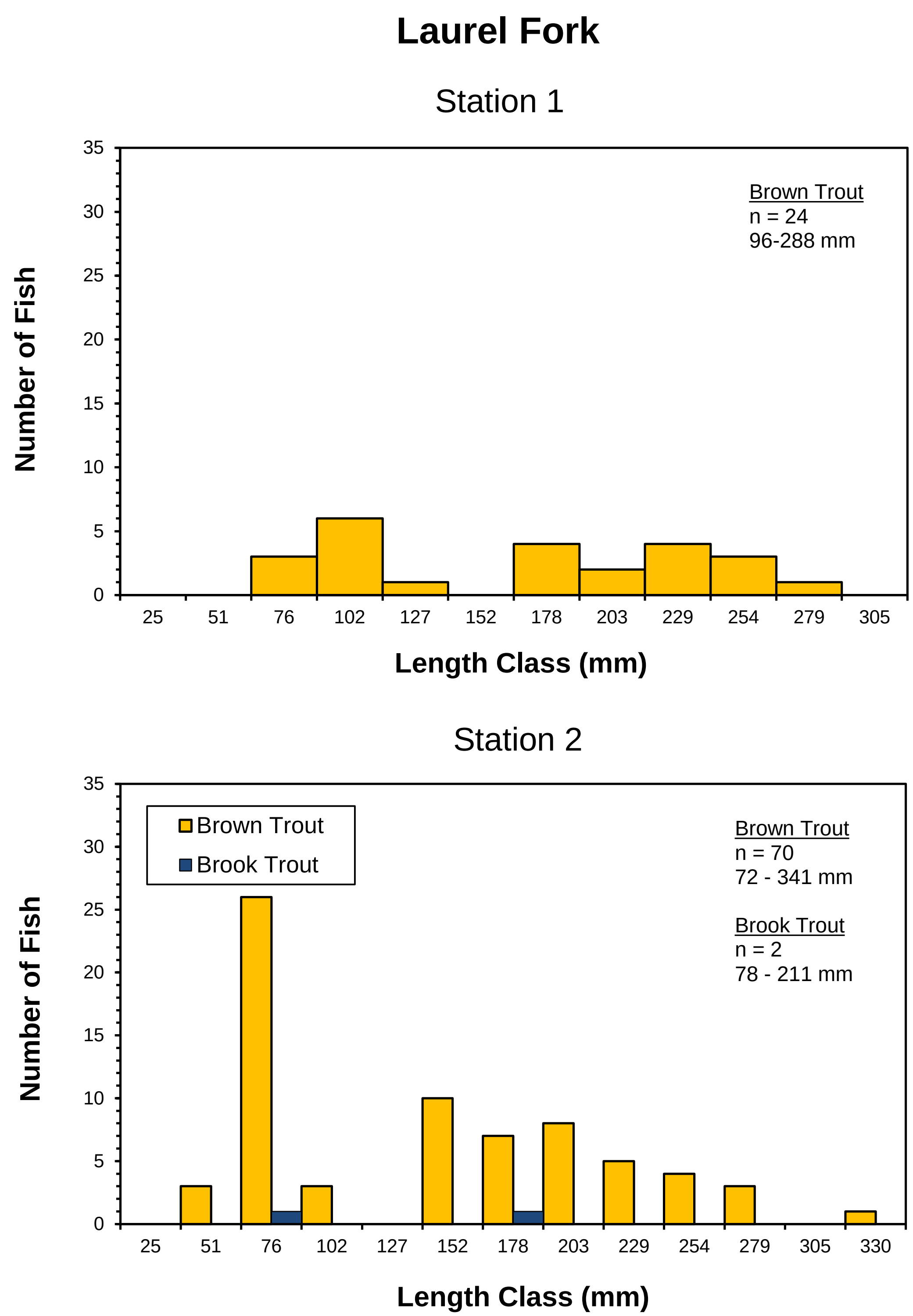


Figure 2-5. Length frequency distributions for Brown Trout and Brook Trout from the 2018 Laurel Fork samples.

Laurel Fork

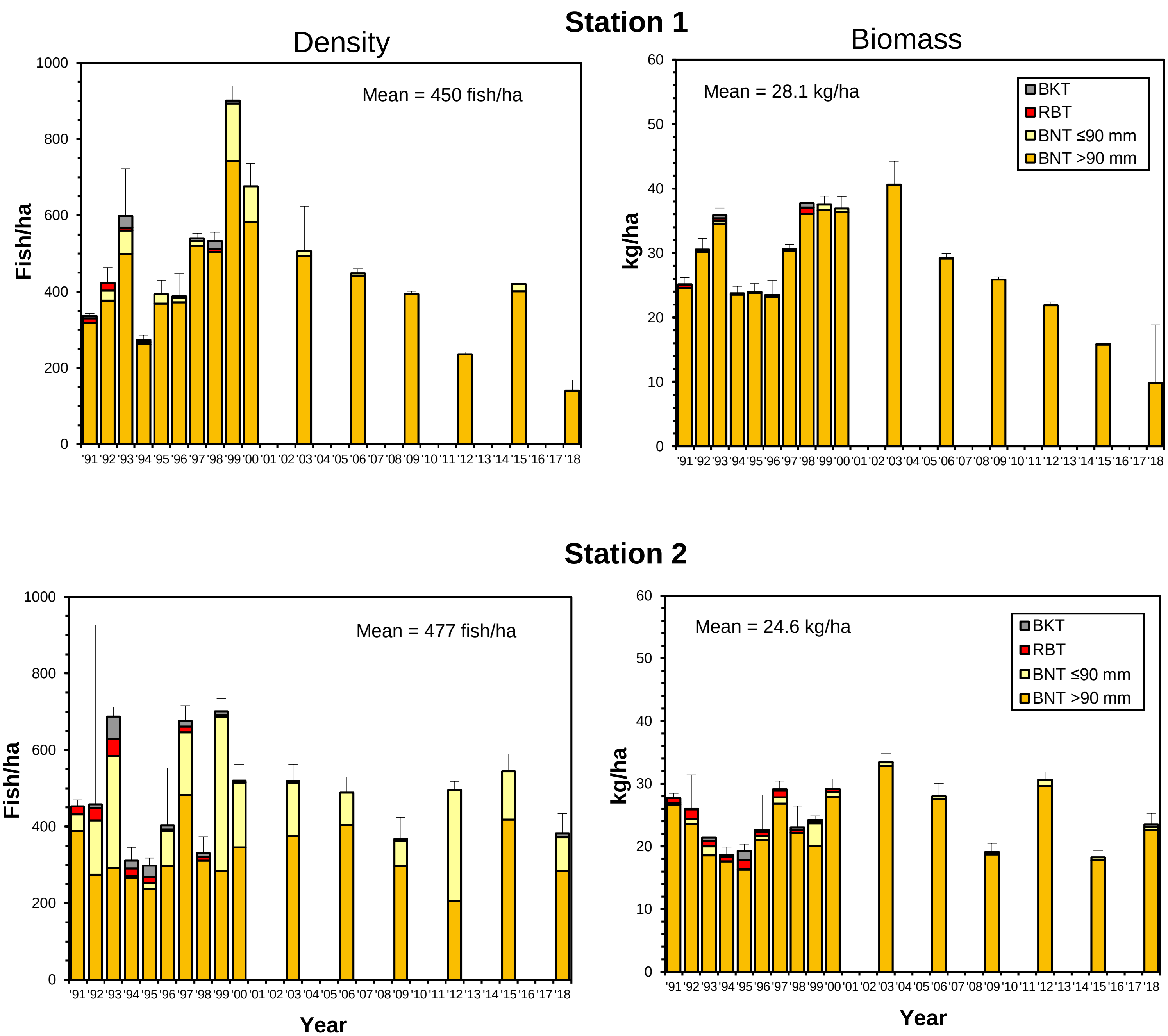


Figure 2-6. Trout abundance estimates for monitoring stations on Laurel Fork in 2018. BNT = Brown Trout, RBT = Rainbow Trout and BKT = Brook Trout. Bars indicate upper 95% confidence limits (total).

2.6 LEFT PRONG HAMPTON CREEK

Study Area

Left Prong of Hampton Creek (Left Prong) flows through the 281-ha (693-acre) Hampton Creek Cove State Natural Area in Carter County and is a tributary to Doe and Watauga rivers. A substantial portion of this area remains as livestock pasture, although fencing prevents livestock access to the stream. Rhododendron (*Rhododendron* spp.), which often dominates the riparian vegetation of other wild trout streams, is absent along Left Prong. Historically, the stream would have been inhabited by Brook Trout, but TWRA found only an abundant wild Rainbow Trout population during a 1988 survey (Bivens 1989). Subsequently, Brook Trout were successfully restored to the upper 2 km of Left Prong during 1999-2000 through a cooperative, multi-agency effort involving TWRA, Overmountain Chapter TU, USFS, NPS, Tennessee Department of Environment and Conservation (TDEC), and the Southern Appalachian Highlands Conservancy. The ineffective modified-culvert fish barrier at the downstream end of the Brook Trout re-establishment zone was replaced in 2007 with a 2.7 m (9') waterfall (Habera and Carter 2008; Habera et al. 2008). Maintenance on this structure was completed in 2015 by Overmountain TU and TWRA. Left Prong was placed under special regulations (three-fish creel limit for Brook Trout; single-hook, artificial lures only) during the establishment period of the new Brook Trout population. It is now managed under TWRA's special wild trout regulations, which include a 5-fish creel limit and no minimum size limit.

A long-term monitoring station (Station 1) was established on lower Left Prong in 1994. Stations 2 and 3 were added in 1996 to better represent the upper portion of the stream, which has a higher gradient and more canopy cover, but have also served to monitor the Brook Trout population since 2000. All three stations have been sampled annually since 1996. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-8.

Cook and Johnson (2016) evaluated post-stocking performance in Left Prong for two cohorts (2013 and 2014) of native Brook Trout fingerlings produced at the Tellico Brook Trout hatchery and at the Tennessee Aquarium Conservation Institute (TNACI; re-circulating system). They found the overall annual survival rate for these fish was lower in Left Prong (16.7%) than in Region 3's Sycamore Creek (34.7%) and for seven pooled wild Brook Trout populations from GSMNP (29.3%; Kulp 1994). A possible explanation for the lower survival of stocked fingerlings in Left Prong is that this stream's higher Brook Trout density reduced growth—and ultimately survival—of the stocked fish (Cook and Johnson 2016).

TNACI has collected adult Brook Trout from Left Prong each of the past two years to spawn at their facility to produce fingerlings for completing the Little Stony Creek native Brook Trout restoration project. In 2018, 10 males were collected from the upper site to be used with the Brook Trout collected last year.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the three stations on Left Prong in 2018 are given in Table 2-9. The 2018 Rainbow Trout density estimate at Station 1 (1298 fish/ha) increased from 2017 due to the large number of age-0 (<90 mm) Rainbow Trout (Figures 2-7 and 2-8). However, few adults were present (Figure 2-8) and biomass continued its overall downward trend, with an all-time low of 15.35 kg/ha in 2018 (Figure 2-7). Poor recruitment to larger size classes has been typical of the Rainbow Trout population at Station 1 during recent years and is unlikely the result of harvest, as fishing pressure on this stream (particularly the Rainbow Trout zone) would be considered light. Increased amounts of silt in the pools compared to previous years. This siltier condition and lower habitat score could be an indicator of declining habitat for Rainbow Trout, which may explain the declining biomass trend.

Previously (1990s), biomass estimates at Station 1 averaged nearly 100 kg/ha and were among the highest obtained for wild Rainbow Trout anywhere in Tennessee. However, biomass has generally declined since 2000 (Figure 2-7) and the recent 10-year average biomass (30.35 kg/ha) and density (2709 fish/ha) are significantly different from the long term average biomass (55.0 kg/ha) and density (4370 fish/ha) (density: $F = 4.47$, $P = 0.04$, $df = 34$; biomass: $F = 6.43$, $P = 0.02$, $df = 34$). This was likely in response to the various droughts that prevailed since 2000, although the trend reversed briefly during 2003-2005 with more normal stream flows. Winter floods in this watershed (particularly in 1998) have also substantially reduced pool habitat at this site (e.g., by partial or complete filling). Roghair et al. (2002) and Carline and McCullough (2003) found that flooding in trout streams caused substantial substrate movement that then decreased pool lengths, surface areas, and depths. Pool depth and quality are correlated with trout abundance (Lewis 1969; Bowlby and Roff 1986), and pools are important trout habitat features (Matthews et al. 1994; Anglin and Grossman 2013; Davis and Wagner 2016), particularly during low flows (Elliott 2000; Sotiropoulos et al. 2006) and for adult Brook Trout (Johnson and Dropkin 1996).

Habitat assessment scores decreased from optimal in 1999-2001 to suboptimal (but not below that ranking) thereafter; while trout abundance estimates have continued to trend downward after 2002. pool quantity and quality in this reach of Left Prong have degraded over time, making it unlikely that it can support the trout biomass it once did. Other variables that are not well represented in the habitat data currently collected (e.g., summer temperature variability, nutrient availability) may also have a role in the trout biomass decline.

Brook Trout abundance at Station 2 decreased slightly from 2017 (Figure 2-7) and biomass at Station 3 remained unchanged from 2017 (total density was lower due to a smaller age-0 cohort; Figure 2-8). Current density (1667 fish/ha) and biomass (39.5 kg/ha) levels at Station 2 are well below the long term averages of 4,293 fish/ha and 74.3 kg/ha, respectively. Degraded pool habitat at Station 2 caused by the 1998 flood (as at Station 1) will likely prevent Brook Trout abundance from reaching the level previously attained by Rainbow Trout (78 kg/ha). Sedimentation of the pools in Station 3 is also becoming increasingly evident and may be responsible for declining abundance, even though it is not well-reflected in the habitat data obtained to date. No Rainbow Trout have been captured at these stations since construction of the new fish barrier in 2007, indicating that it is effectively preventing encroachment by Rainbow Trout from downstream.

Left Prong was included in the multi-agency Tennessee's Ecologically At-Risk Stream—Appalachian Mountains (TEARS-AM) project to collect baseline chemical, physical and biological data on stream sections with naturally reproducing Brook Trout populations within the CNF and GSMNP. The project goal is to investigate global, regional and/or local influences on stream health and food chain dynamics such as climate change and atmospheric deposition of mercury. Results (Olson et al. 2019) indicated no impairment from sediment, nutrients, organic compounds (e.g., pesticides), and metals except aluminum (Al). Drops in pH (aided by low natural alkalinity/hardness) and concurrent spikes in naturally occurring Al during high flow events can affect gas exchange at fish gills. Methylmercury levels were very low in aquatic insects (trichopterans) and water striders (*Gerris*), as well as Brook Trout and Rainbow Trout. Whole-body methylmercury levels in trout from Left Prong and three other streams in the CNF (Gentry Creek and Bald River) and GSMNP (Rock Creek) averaged 0.037 ± 0.003 µg/kg (Olson et al. 2019). Interestingly, methylmercury levels in tetragnathid spiders, which build webs above the stream surface to catch emerging insects, can be very high.

Left Prong was also selected as one of several wild trout streams to be screened in 2018 for *Myxobolus cerebralis*, the causative parasite for Whirling Disease. Sixty fingerling (age-0) Rainbow Trout were collected in July from the reach between the confluence with Hampton Creek and the Brook Trout zone barrier and shipped to the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University for analysis using nested PCR tests and digest/microscopic examinations for myxospores. Results were negative.

Management Recommendations

Upper Left Prong's Brook Trout population has made it one of Tennessee's premier Brook Trout fisheries. Since fully established in 2003, mean Brook Trout biomass for the upper station (74 kg/ha) has substantially exceeded the statewide average for other streams (about 21 kg/ha), and is comparable to the mean biomass for the previous Rainbow Trout population (81 kg/ha). Native Brook Trout may be better adapted to and more tolerant of drought conditions (common during the past decade) than are nonnative Rainbow Trout. Monitoring data from other streams such as Gentry Creek (Section 2.9.3) and upper Rocky Fork (Section 2.9.4) also indicate Brook Trout have greater drought tolerance compared to Rainbow Trout. Management of Left Prong should feature its Brook Trout fishery and development of this important database should continue through annual monitoring at all three sites.

Because of the decreasing biomass and density trends at all three stations, suboptimal habitat scores, and decreasing quantity and quality pools, a more detailed habitat analysis may be useful. Deployment of instream water temperature loggers would also help identify any potential effects on Brook Trout abundance related to temperature.

Table 2-8. Site and sampling information for Left Prong Hampton Creek in 2018.

Location	**Station 1**		**Station 2**		**Station 3**	
Site code	420182001		420182002		420182003	
Sample date	17 July		17 July		17 July	
Watershed	Watauga River		Watauga River		Watauga River	
County	Carter		Carter		Carter	
Quadrangle	White Rocks Mtn. 208 NE		White Rocks Mtn. 208 NE		White Rocks Mtn. 208 NE	
Lat-Long	36.15132 N, -82.05324 W		36.14673 N, -82.04917 W		36.13811 N, -82.04473 W	
Reach number	06010103		06010103		06010103	
Elevation (ft)	3,080		3,240		3,560	
Stream order	2		2		2	
Land ownership	State (Hampton Cove)		State (Hampton Cove)		State (Hampton Cove)	
Fishing access	Good		Good		Good	
Description	Begins ~10 m upstream of the first foot bridge.		Begins 50 m upstream of the fish barrier.		Begins 880 m upstream of the upper end of Site 2.	
Effort						
Station length (m)	106		94		100	
Sample area (m²)	340		423		360	
Personnel	7		7		4	
Electrofishing units	1		1		1	
Voltage (AC)	350		500		500	
Removal passes	3		3		3	
Habitat						
Mean width (m)	3.2		4.5		3.6	
Maximum depth (cm)	35		N/M		0.70	
Canopy cover (%)	70		90		95	
Aquatic vegetation	scarce		scarce		scarce	
Estimated % of site in pools	38		45		N/M	
Estimated % of site in riffles	62		55		N/M	
Habitat assessment score	156 (suboptimal)		157 (suboptimal)		159 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**				
Silt	20	0	5	0	25	0
Sand	10	5	10	10	10	5
Gravel	30	40	40	25	20	30
Rubble	35	45	20	45	15	35
Boulder	5	10	25	20	25	25
Bedrock	0	0	0	0	5	5
Water Quality						
Flow (cfs; visual)	1.2; normal		N/M; normal		1.4; normal	
Temperature (C)	18.7		17.8		16.3	
pH	6.9		7.0		7.0	
Conductivity (µS/cm)	38		31.5		20.3	
Dissolved oxygen (mg/L)	N/M		N/M		N/M	
Alkalinity (mg/L $CaCO_3$)	20		N/M		N/M	

Table 2-9. Fish population abundance estimates (with 95% confidence limits) for the monitoring stations on Left Prong Hampton Creek sampled 17 July 2018.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Weight (g)	Mean Fish Wt. (g)	Biomass (kg/ha) Est.	Biomass (kg/ha) Lower C.L.	Biomass (kg/ha) Upper C.L.	Density (fish/ha) Est.	Density (fish/ha) Lower C.L.	Density (fish/ha) Upper C.L.
Station 1												
RBT ≤90 mm	34	36	34	42	162	4.5	4.78	4.51	5.58	1,062	1,003	1,239
RBT >90 mm	8	8	8	8	359	44.9	10.60	16.33	10.60	236	236	236
BKT >90 mm	0	0	0	0	0	0.0	0.00	0.00	0.00	0	0	0
Blacknose Dace	98	109	98	122	425	3.9	12.54	11.27	14.04	3,215	2,891	3,599
Fantail Darter	11	14	11	29	46	3.3	1.36	1.07	2.82	413	324	855
Totals	**151**	**167**	**151**	**201**	**993**		**29.28**	**33.19**	**33.03**	**4,926**	**4,454**	**5,929**
Station 2												
BKT ≤90 mm	31	35	31	45	109	3.1	2.57	2.27	3.30	827	733	1,064
BKT >90 mm	29	29	29	30	792	27.3	18.72	18.72	19.36	686	686	709
Totals	**60**	**64**	**60**	**75**	**900**		**21.28**	**20.99**	**22.66**	**1,513**	**1,418**	**1,773**
Station 3												
BKT ≤90 mm	11	11	11	12	45	4.1	1.25	1.25	1.37	306	306	333
BKT >90 mm	49	49	49	51	1,377	28.1	38.25	38.25	39.81	1,361	1,361	1,417
Totals	**60**	**60**	**60**	**63**	**1,422**		**39.50**	**39.50**	**41.18**	**1,667**	**1,667**	**1,750**

Note: RBT = Rainbow Trout and BKT = Brook Trout.

Left Prong Hampton Creek

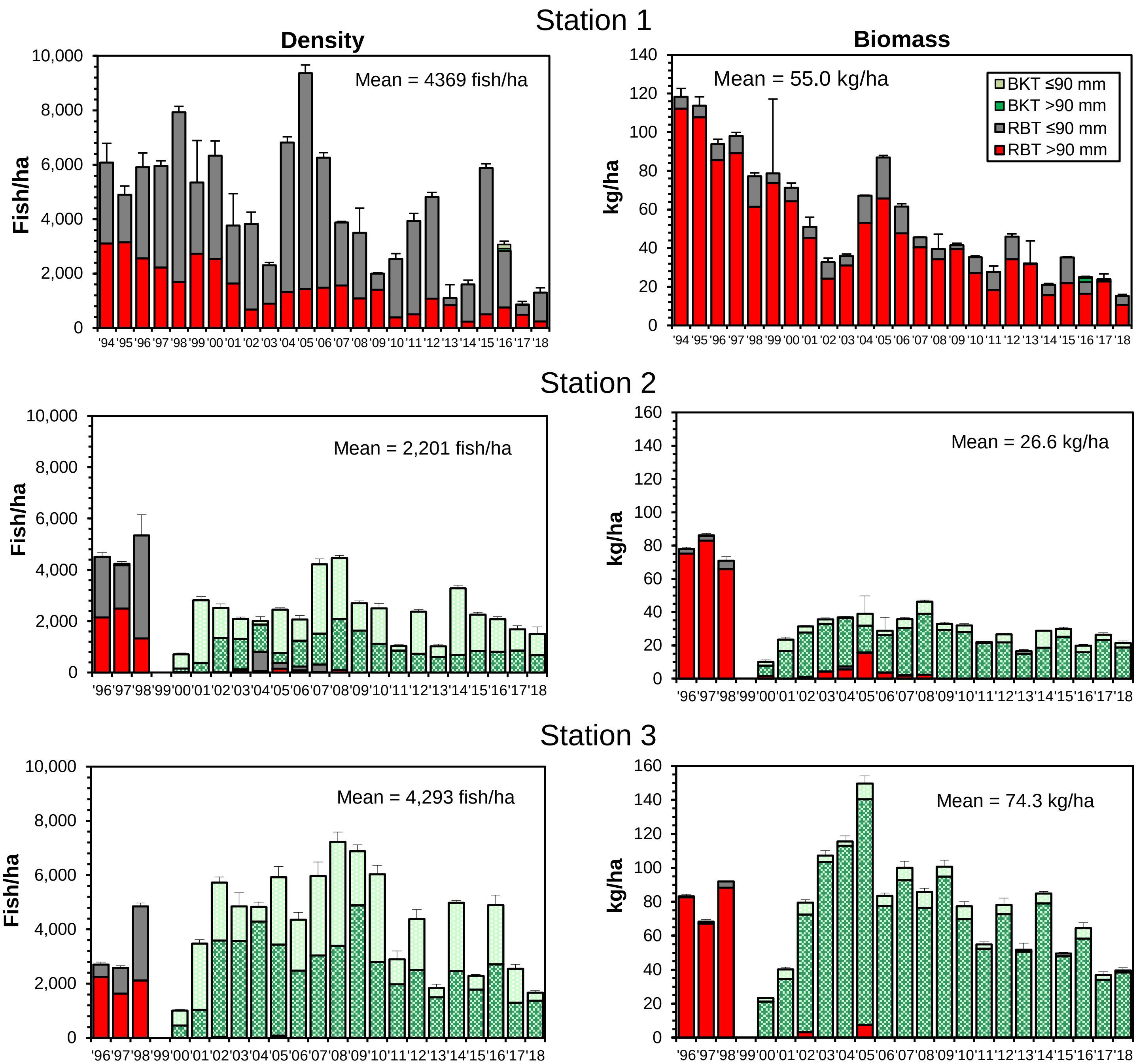


Figure 2-7. Trout abundance estimates for the Left Prong Hampton Creek monitoring stations. RBT = Rainbow Trout and BKT = Brook Trout. Bars indicate upper 95% confidence limits.

Left Prong Hampton Creek

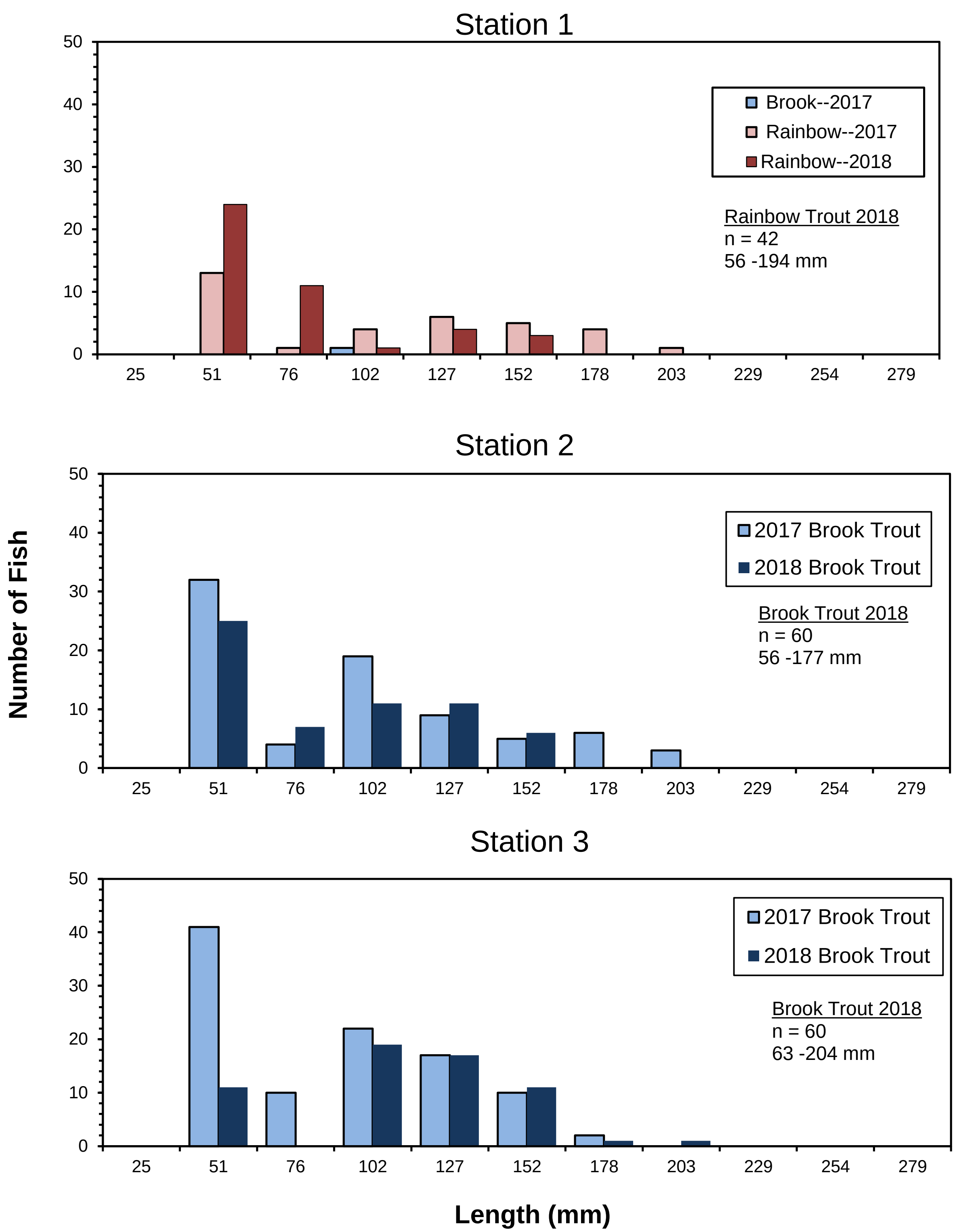


Figure 2-8. Length frequency distributions for trout from the 2017 and 2018 Left Prong Hampton Creek samples.

2.7 RIGHT PRONG MIDDLE BRANCH

Study Area

Right Prong Middle Branch is a headwater tributary to the Doe and Watauga rivers. Its Roan Mountain watershed is forested and located largely within the CNF in Carter County. It supports an allopatric population of native Brook Trout upstream of State Route 143 first documented by Bivens (1979). The current monitoring station was first sampled in 1994 (Strange and Habera 1995) and was added to the monitoring program in 1997 to represent a high-elevation (above 4,000' or 1,220 m) native Brook Trout population. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-10.

Results and Discussion

Catch data and abundance estimates for Brook Trout sampled at the monitoring station in 2018 are given in Table 2-11. Despite some relatively strong cohorts in recent years, biomass has decreased 70% since 2012 (from 76 kg/ha to 23 kg/ha in 2018) and has been below the long-term mean of about 47 kg/ha since the extreme drought in 2016 (Figure 2-9). Most of the biomass decline over the past year can be attributed to the presence of fewer large (≥178 mm) Brook Trout in 2018 (Figure 2-10). No particular habitat changes at this site (e.g., pool quality degradation) have been apparent in previous years, although evidence this year suggested a major high-flow event (or multiple events) occurred with substantial effects on pool habitat. Several pools had filled in with bedload and only one significant new pool was formed. This high-flow event may have also been responsible for the poor age-0 cohort represented in the 2018 sample (Figure 2-10).

Management Recommendations

No special management of Right Prong Middle Branch is suggested at this time other than protection of the resource. Because of the small size of this stream and its relative obscurity, angling pressure is probably light. Sampling at the monitoring station should continue in order to increase our understanding of Brook Trout population dynamics, particular in higher-elevation streams. Temperature loggers should also be deployed for long-term water temperature monitoring, particularly summer months.

Table 2-10. Site and sampling information for Right Prong Middle Branch in 2018.

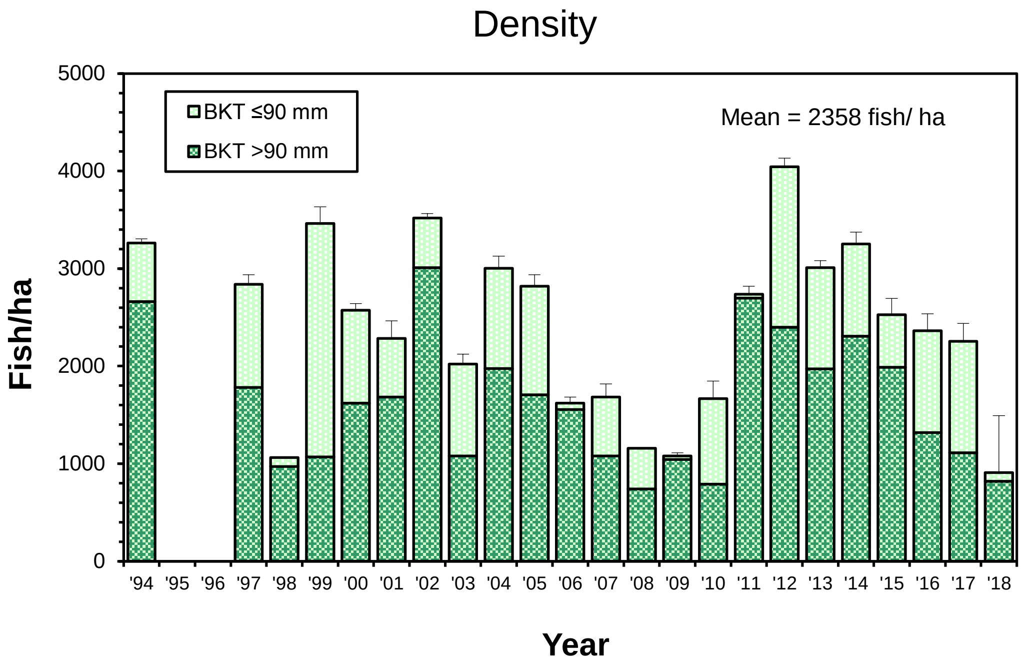
Location	**Station 1**	
Site code	420182301	
Sample date	17 August	
Watershed	Watauga River	
County	Carter	
Quadrangle	Carvers Gap 208 SE	
Lat-Long	36.12007 N, -82.09574 W	
Reach number	06010103	
Elevation (ft)	4,070	
Stream order	1	
Land ownership	USFS	
Fishing access	Limited	
Description	Begins at head of small island ~270 m upstream of Rt. 143.	
Effort		
Station length (m)	90	
Sample area (m^2)	342	
Personnel	2	
Electrofishing units	1	
Voltage (AC)	250	
Removal passes	3	
Habitat		
Mean width (m)	3.8	
Maximum depth (cm)	85	
Canopy cover (%)	95	
Aquatic vegetation	scarce	
Estimated % of site in pools	28	
Estimated % of site in riffles	72	
Habitat assessment score	NM	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	25	0
Sand	5	5
Gravel	30	30
Rubble	15	30
Boulder	20	35
Bedrock	5	0
Water Quality		
Flow (cfs; visual)	1.8; normal	
Temperature (C)	13.9	
pH	6.9	
Conductivity (µS/cm)	51	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	15	

Table 2-11. Fish population abundance estimates (with 95% confidence limits) for the monitoring station on Right Prong Middle Branch sampled 17 August 2018.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Weight (g)	Mean Fish Wt. (g)	Biomass (kg/ha) Est.	Biomass (kg/ha) Lower C.L.	Biomass (kg/ha) Upper C.L.	Density (fish/ha) Est.	Density (fish/ha) Lower C.L.	Density (fish/ha) Upper C.L.
BKT ≤90 mm	3	3	3	14	11	3.5	0.32	0.31	1.43	88	88	409
BKT >90 mm	25	28	19	37	784	28.0	22.92	28.78	30.29	819	556	1,082
Totals	**28**	**31**	**22**	**51**	**795**		**23.25**	**29.09**	**31.73**	**906**	**643**	**1,491**

Note: BKT = Brook Trout.

Right Prong Middle Branch



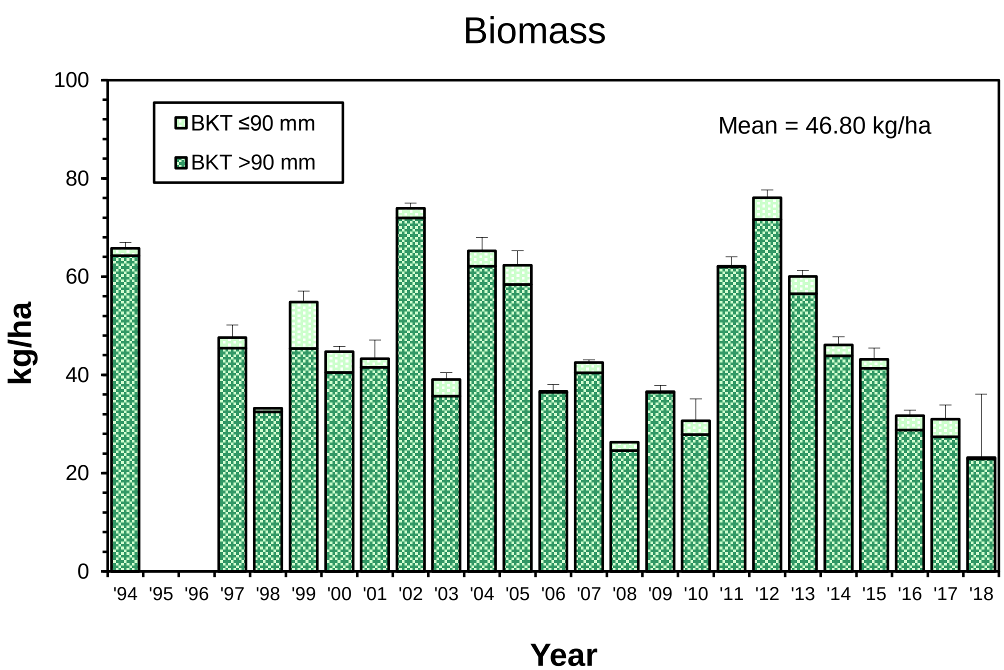


Figure 2-9. Trout abundance estimates for the Right Prong Middle Branch monitoring station for 2018. BKT = Brook Trout. Bars indicated upper 95% confidence limits (total).

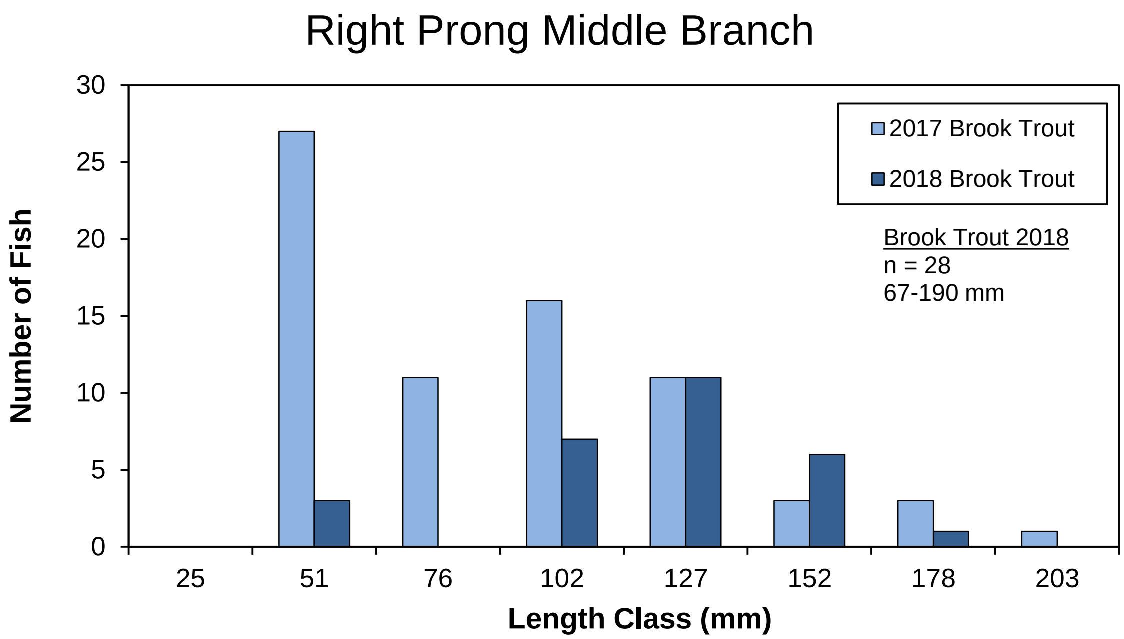


Figure 2-10. Length frequency distribution for Brook Trout from the 2017 and 2018 Right Prong Middle Branch samples.

2.8 ROCKY FORK

The lower wild trout monitoring station on Rocky Fork (Station 1) was not sampled in 2018 due to frequent high flows. Station 2 in the sympatric Brook/Rainbow zone was sampled (see Section 2.9.4 below).

Rocky Fork was selected as one of several wild trout streams to be screened in 2018 for *Myxobolus cerebralis*, the causative parasite for Whirling Disease. Sixty fingerling (age-0) Rainbow Trout were collected from a 1.2 km reach in the lower portion of the stream (primarily downstream of Station 1) in September and shipped to the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University for analysis using nested PCR tests and digest/microscopic examinations for myxospores. Results were negative.

2.9 SYMPATRIC BROOK/TRAINBOW TROUT MONIORING STREAMS

Four streams (upper Rocky Fork, Briar Creek, Birch Branch, and Gentry Creek) are currently being monitored annually with the objective of documenting how (or if) Rainbow Trout eventually replace Brook Trout in areas where the two species occur sympatrically.

2.9.1 Birch Branch

Study Area

Birch Branch is a Beaverdam Creek tributary in Johnson County that flows through a mountainous, forested watershed primarily within the CNF (the lower 0.8 km is on private land). It contains 4.6 km of native Brook Trout water beginning at an elevation of 779 m (2,555'). Allopatric Brook Trout occupy the upper 2.3 km of this distribution (Bivens et al. 1985). In addition to wild Rainbow Trout, some Brown Trout are also occasionally present, particularly near the confluence with Beaverdam Creek. Birch Branch is subject to general, statewide trout angling regulations.

Birch Branch was previously surveyed by TWRA (1960s) and USFS (1970s) to document the presence of Brook Trout (Bivens 1984). Bivens (1984) recommended construction of a barrier in the lower portion of the stream and removal of the encroaching Rainbow Trout. This has not been done, thus providing an opportunity to monitor population trends in the sympatric zone. A station at 872 m (2,860') containing 97% Brook Trout was quantitatively sampled during distribution surveys in 1991 (Strange and Habera 1992). A site further downstream at 823 m (2,700') with more Rainbow Trout was established and annual monitoring began in 1995(Strange and Habera 1996). Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-12.

Results and Discussion

Catch data and abundance estimates for trout sampled at the Birch Branch station in 2018 are given in Table 2-13. Recruitment remains slightly depressed in Birch Branch as few (<10) adult trout (≥ 127 mm) have been present in recent years, including 2018 (9 trout ≥ 127 mm; Figure 2-11) and total trout biomass is below the long-term average of 13.25 kg/ha. One large Brown Trout (286 mm) was also captured in the same pool that formerly produced a similarly-sized fish for three consecutive years (2010-2012).

Brook Trout relative abundance in terms of biomass generally increased from about 30% in 1995 to over 70% in 2002, with much of the change occurring during the 1998-2002 drought (Figure 2-12). The steep decline from 2009-2010 (to 23%) is likely related to cumulative effects of previous droughts on recruitment, as populations of both species were reduced to the extent that relative abundance percentages become much less meaningful. This also occurred in Briar Creek and Rocky Fork in 2010. Brook Trout relative abundance (biomass) has generally increased since 2010, exceeding 50% in most years and 60% in 2018. The increase since 2016 was likely linked to the drought that year, which tends to favor Brook Trout abundance in successive years.

Management Recommendations

The wild trout fishery in Birch Branch is not particularly noteworthy, although it does include native, Brook Trout that should be maintained. Continued monitoring at the Birch Branch station will help further our understanding of Brook and Rainbow trout interactions in sympatry and gauge the ability of Rainbow Trout to replace Brook Trout. It is recommended that no efforts to remove Rainbow Trout or enhance Brook Trout be undertaken in Birch Branch while this monitoring is underway so that only natural processes can be studied.

Table 2-12. Site and sampling information for Birch Branch in 2018.

Location	**Station 1**	
Site code	420182101	
Sample date	19 July	
Watershed	S. Fork Holston River	
County	Johnson	
Quadrangle	Laurel Bloomery 213 SE	
Lat-Long	36.55629 N, -81.86941 W	
Reach number	06010102	
Elevation (ft)	2,700	
Stream order	2	
Land ownership	Private	
Fishing access	Good	
Description	This monitoring station ends at the USFS boundary markers (at first trail crossing).	
Effort		
Station length (m)	144	
Sample area (m²)	504	
Personnel	5	
Electrofishing units	1	
Voltage (AC)	400	
Removal passes	3	
Habitat		
Mean width (m)	3.5	
Maximum depth (cm)	96	
Canopy cover (%)	95	
Aquatic vegetation	scarce	
Estimated % of site in pools	45	
Estimated % of site in riffles	55	
Habitat assessment score	157 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	0
Sand	10	5
Gravel	30	25
Rubble	40	50
Boulder	15	20
Bedrock	0	0
Water Quality		
Flow (cfs; visual)	2.05; normal	
Temperature (C)	17.9	
pH	6.8	
Conductivity (µS/cm)	15.6	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	NM	

Table 2-13. Fish population abundance estimates (with 95% confidence limits) for the monitoring station on Birch Branch sampled 19 July 2018.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Weight (g)	Mean Fish Wt. (g)	Biomass (kg/ha) Est.	Biomass (kg/ha) Lower C.L.	Biomass (kg/ha) Upper C.L.	Density (fish/ha) Est.	Density (fish/ha) Lower C.L.	Density (fish/ha) Upper C.L.
RBT ≤90 mm	42	44	42	50	65	1.5	1.29	1.25	1.49	873	833	992
RBT >90 mm	4	4	4	15	112	28.0	2.22	2.22	8.33	79	79	298
BKT ≤90 mm	16	19	16	31	64	3.4	1.27	1.08	2.09	377	317	615
BKT >90 mm	11	11	11	14	256	23.3	5.08	5.09	6.47	218	218	278
BNT > 90 mm	1	1	1	1	240	240.0	4.76	4.76	4.76	20	20	20
Totals	**74**	**79**	**74**	**111**	**737**		**14.62**	**14.40**	**23.15**	**1,567**	**1,468**	**2,202**

Note: RBT = Rainbow Trout; BKT = Brook Trout; BNT = Brown Trout

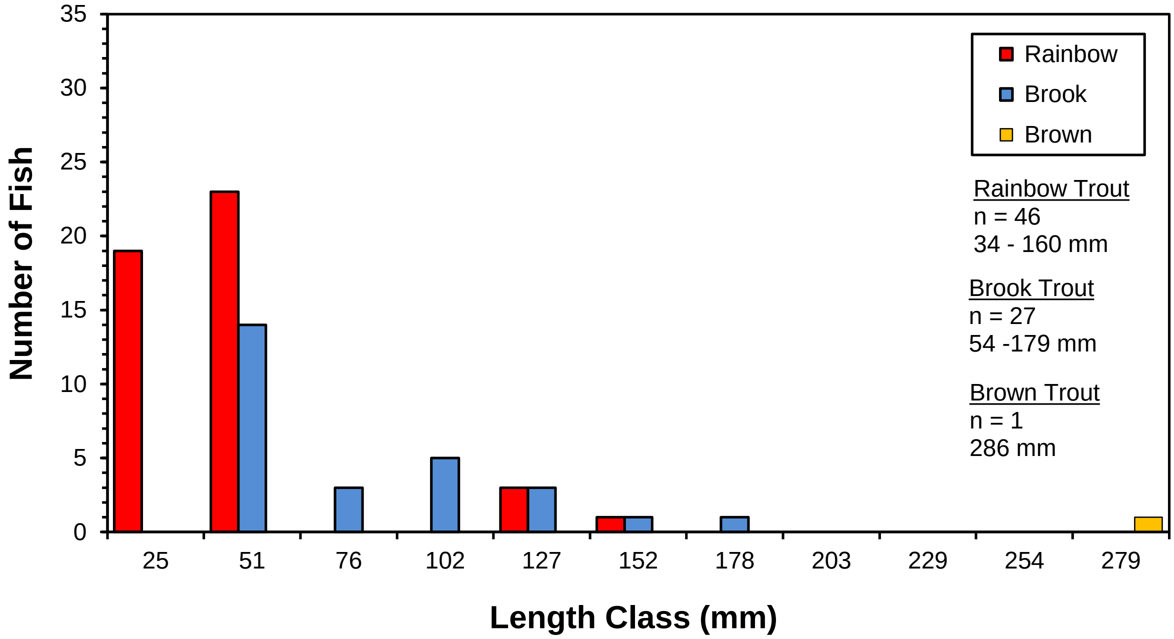


Figure 2-11. Length frequency distribution for Brook Trout, Rainbow Trout, and Brown Trout from the 2018 Birch Branch sampling.

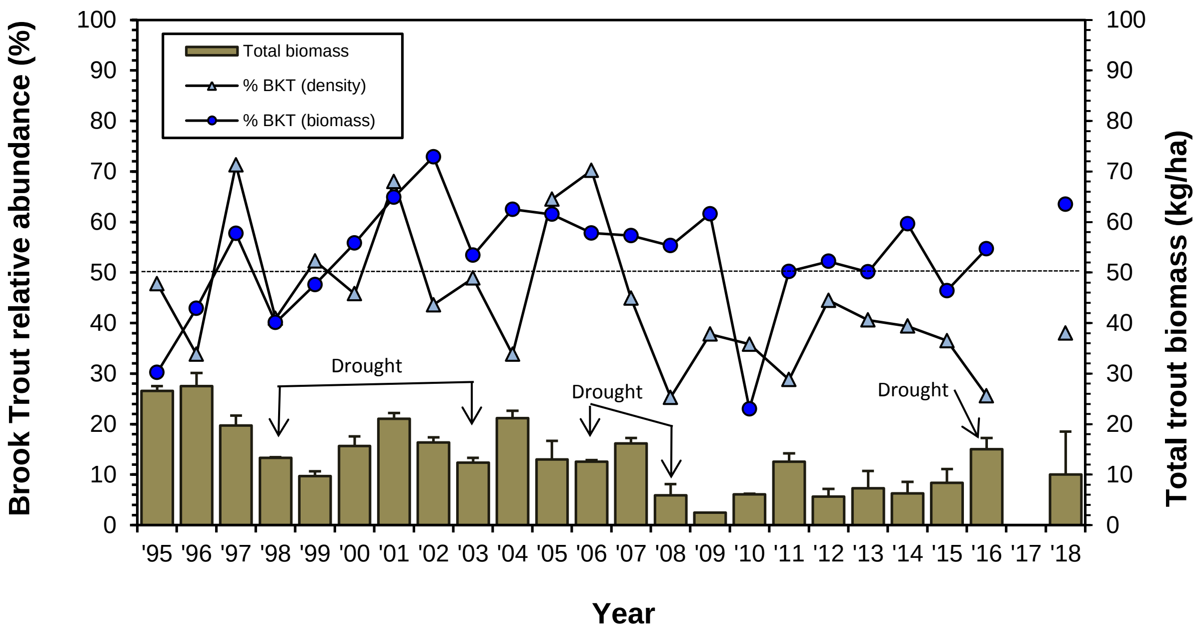


Figure 2-12. Total biomass and relative Brook Trout abundance at the Birch Branch monitoring station. Bars indicate upper 95% confidence limits.

2.9.2 Briar Creek

Study Area

Briar Creek is a Nolichucky River tributary in Washington County that flows from Buffalo Mountain through a forested watershed located within the CNF. It contains 4.7 km of native Brook Trout water beginning at an elevation of about 657 m (2,140'). Rainbow Trout are present throughout the stream to its confluence with Dry Creek. Brook Trout were re-introduced to Briar Creek in 1983 and the existing Rainbow Trout population was thinned in the 1.37-km introduction zone during 1983-1986 (Nagel 1986). A total of 114 native Brook Trout (mixed ages) were translocated from East Fork Beaverdam Creek, George Creek, and Tiger Creek during 1983-1984 (Nagel 1986). A reproducing Brook Trout population became established in the introduction zone by 1986, and then expanded into areas no Rainbow Trout were removed from (Nagel 1991). Currently, Brook Trout inhabit 4.7 km of Briar Creek, all of which remains sympatric with Rainbow Trout. DNA samples were obtained from 30 fish in 2016 to confirm their genetic identity and obtain other population genetics information; results are pending. Briar Creek is currently subject to general, statewide trout angling regulations.

A station at 662 m (2,170') elevation was quantitatively sampled in 1992 to check the Brook Trout population status in the original introduction zone (Strange and Habera 1993). This site contained 27% Brook Trout, but several were removed for genetic analyses (Kriegler et al. 1995). Therefore, a new site was established at 671 m (2,200') and annual monitoring began in 1995 (Strange and Habera 1996). Site location and effort details, along with habitat and water quality information are summarized in Table 2-14.

Results and Discussion

Catch data and abundance estimates for trout and all other species sampled at the Briar Creek station in 2018 are given in Table 2-15. Briar Creek has been impacted by droughts since 1998, resulting in August flows typically well below 1 cfs. Only six fish (two Brook Trout) were captured in 2010 (Habera et al. 2011), but better flow conditions by 2014 and 2015 led to a substantial increase in trout abundance (>100 fish) with numerous age-0 fish of both species (Habera et al. 2015a and 2016). However, total trout numbers were reduced by extremely dry conditions and low stream flows again in 2016 and declined further in 2017 and 2018. Only eight Brook Trout (no adults) were captured this year (Figure 2-14).

Total trout biomass at the Briar Creek monitoring station generally declined from the late 1990s through 2013 in conjunction with the previously-mentioned droughts during that time (Figure 2-15). Following the improvement to 32 kg/ha in 2014, biomass has consistently declined again to 10 kg/ha in 2017 and to the lowest level yet observed in 2018 (2.1 kg/ha; Figure 2-15). Brook Trout relative biomass generally increased at the Briar Creek monitoring station during 1997-2002, exceeding 50% during the drought years of 1998-2002 (Figure 2-15). However, it has been below 50% since 2002, with a low of about 10% in 2017 (following the extreme 2016 drought). Relative Brook Trout biomass increased to 43% in 2018—even in the absence of any adults—and relative density exceeded 50% for the first time since 2003 (Figure 2-15). However, these improvements should be viewed cautiously given the sample sizes (Table 2-15). Given its persistence over the past three decades, this Brook Trout population is obviously resilient and has been capable of withstanding a combination of environmental and competitive challenges. Low trout numbers, particularly adults, are concerning but age-0 trout are present each year indicating some of these fish are surviving to reproductive age.

Management Recommendations

Upper Briar Creek typically supports a good wild trout fishery featuring Brook Trout except when reduced by droughts. Fortunately, wild trout populations (particularly Brook Trout in Briar Creek) tend to be resilient and this fishery will likely recover from recent drought-related impacts. Annual sampling at the monitoring station should continue in order to learn more about Brook Trout and Rainbow Trout populations under sympatric conditions, particularly their responses to abiotic events (droughts and floods). No efforts to remove Rainbow Trout or enhance Brook Trout should occur in upper Briar Creek while this monitoring is underway so that only natural processes can be studied. A temperature logger may also be deployed for monitoring water temperature during summer and early fall.

The culvert at the upper road crossing (FR 188; above the monitoring station), which had a perched downstream lip, was recently replaced by the USFS and TU with a new structure that will improve connectivity with the upstream Brook Trout population.

Table 2-14. Site and sampling information for Briar Creek in 2018.

Location	Station 1	
Site code	420182201	
Sample date	14 August	
Watershed	Nolichucky River	
County	Washington	
Quadrangle	Erwin 199 NW	
Lat-Long	36.22825 N, -82.38883 W	
Reach number	06010108	
Elevation (ft)	2,200	
Stream order	3	
Land ownership	USFS	
Fishing access	Good	
Description	This site is located along the adjacent road (USFS 188). The lower end is marked	
Effort		
Station length (m)	145	
Sample area (m²)	667	
Personnel	2	
Electrofishing units	1	
Voltage (AC)	350	
Removal passes	3	
Habitat		
Mean width (m)	4.6	
Maximum depth (cm)	0.75	
Canopy cover (%)	85	
Aquatic vegetation	scarce	
Estimated % of site in pools	35	
Estimated % of site in riffles	65	
Habitat assessment score	151 (suboptimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	0	0
Sand	15	5
Gravel	40	35
Rubble	30	45
Boulder	10	15
Bedrock	5	0
Water Quality		
Flow (cfs; visual)	1.08; normal	
Temperature (C)	17.7	
pH	6.9	
Conductivity (μS/cm)	38	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	20	

Table 2-15. Fish population abundance estimates (with 95% confidence limits) for the monitoring station on Briar Creek sampled 14 August 2018.

Species	Total Catch	Population Size Est.	Lower C.L.	Upper C.L.	Est. Weight (g)	Mean Fish Wt. (g)	Biomass (kg/ha) Est.	Lower C.L.	Upper C.L.	Density (fish/ha) Est.	Lower C.L.	Upper C.L.
RBT ≤90 mm	8	8	8	11	38	4.7	0.56	0.56	0.78	120	120	165
RBT >90 mm	1	1	1	1	39	38.5	0.58	0.58	0.58	15	15	15
BKT ≤90 mm	11	11	11	16	53	4.8	0.79	0.79	1.15	165	165	240
BKT >90 mm	1	1	1	1	9	9.2	0.14	0.14	0.14	15	15	15
Blacknose Dace	192	203	192	214	508	2.5	7.61	7.20	8.02	3,043	2,879	3,208
Totals	**213**	**224**	**213**	**243**	**646**		**9.68**	**9.27**	**10.66**	**3,358**	**3,193**	**3,643**

Note: RBT = Rainbow Trout and BKT = Brook Trout.

Briar Creek

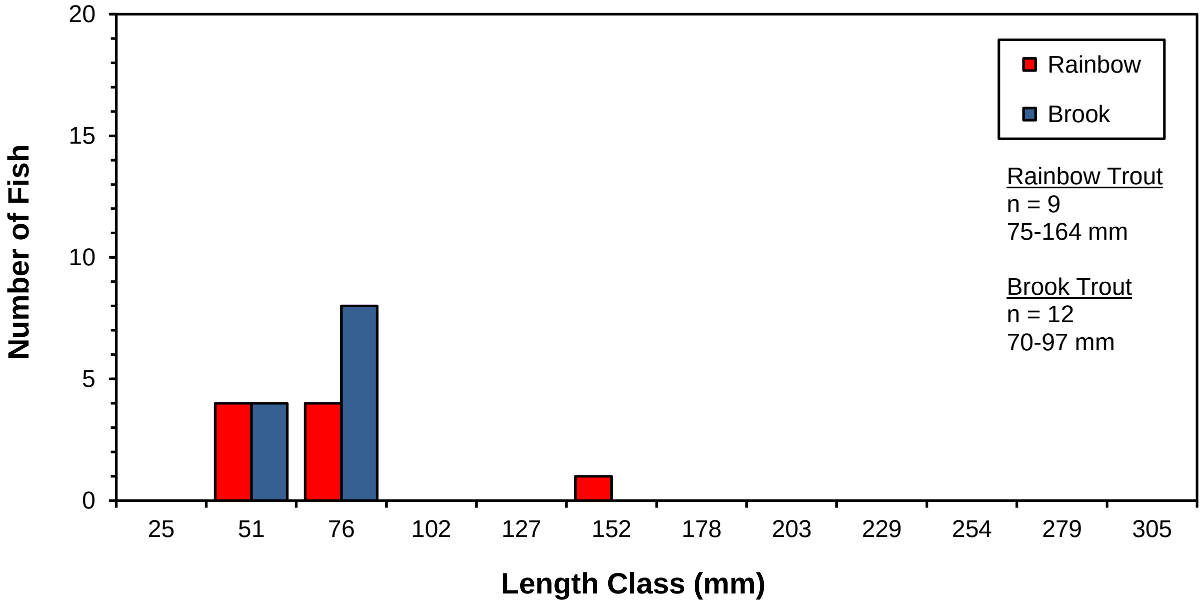


Figure 2-14. Length frequency distribution for Rainbow Trout and Brook Trout from the 2018 Briar Creek sample.

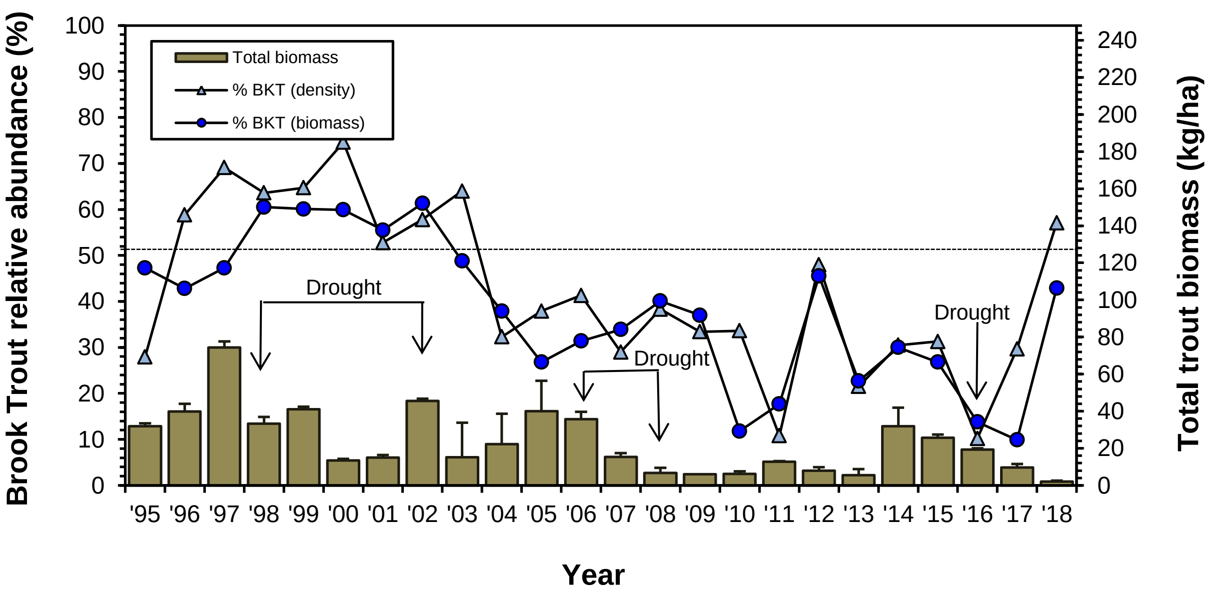


Figure 2-15. Total biomass and relative Brook Trout abundance at the Briar Creek monitoring station. Bars indicate upper 95% confidence limits.

2.9.3 Gentry Creek

Study Area

Gentry Creek is a tributary of Laurel Creek in Johnson County and flows through a mountainous, forested watershed primarily within the CNF. It has about 8 km of Brook Trout distribution beginning at 768 m (2,520') elevation. Allopatric, native Brook Trout inhabit the stream above a large falls at about 1,024 m (3,360'). Below the falls is a 5.8-km section containing both Brook and Rainbow trout. Downstream of that reach (to the confluence with Laurel Creek) Rainbow Trout dominate, with some Brown Trout present. Four Gentry Creek tributaries (Grindstone Branch, Cut Laurel Branch, Kate Branch, and Gilbert Branch) provide another 6.8 km of native Brook Trout water. The entire watershed is currently under general statewide trout angling regulations.

Gentry Creek was surveyed by TWRA in the 1960s and by the USFS in the 1970s to document the presence of Brook Trout (reviewed by Bivens 1984). Bivens (1984) recommended that a barrier be constructed below Grindstone Branch and Rainbow Trout removed from the area upstream. No action has been taken to date, thus providing an opportunity to monitor trout population trends in the sympatric zone. A station at 963 m elevation (3,160') in the sympatric zone was sampled in 1992 (Strange and Habera 1993) and was added to the annual monitoring program in 1996. Sample site location and effort details, along with habitat and water quality information are summarized in Table 2-16.

Results and Discussion

Catch data and abundance estimates for trout and other species sampled at the Gentry Creek station in 2018 are given in Table 2-17. A relatively strong 2018 Brook Trout cohort was present, although only three adults were captured (vs. 11 adult Rainbow Trout; Figure 2-16). Estimated total trout biomass (15.3 kg/ha) was the lowest since 2009 (Figure 2-17).

Floods have been implicated in the alteration of species composition in favor of Rainbow Trout where they occur sympatrically with Brook Trout (Seegrist and Gard 1972; Nagel 1991; Warren et al. 2009). Gentry Creek demonstrated this effect as trout abundance had changed from predominantly Brook Trout to predominantly Rainbow Trout after two floods during 1992-1994 (Figure 2-17). Droughts can have the opposite effect; however, as Brook Trout relative abundance (biomass) exceeded 90% in 2002 following low flows during 1998-2002 (Figure 2-17). As more normal flows returned after 2002 Rainbow Trout recovered and Brook Trout relative abundance began a general decline similar to that observed in Briar Creek, Rocky Fork, and Birch Branch. Brook Trout relative abundance increased again with the resumption of drought conditions in 2006 and reached 100% in 2009 (Figure 2-17), although some age-0 Rainbow Trout were present in Gentry Creek in 2009, since yearlings were captured in 2010. Brook Trout relative abundance (biomass) has declined since 2015, but remains at 70%. Clearly, Gentry Creek's Brook Trout, like those in the other monitoring streams, are capable of long-term coexistence with Rainbow Trout and competition from them can be substantially diminished during droughts.

Gentry Creek was included in the multi-agency Tennessee's Ecologically At-Risk Stream—Appalachian Mountains (TEARS-AM) project to collect baseline chemical, physical and biological data on stream sections with naturally reproducing Brook Trout populations within the CNF and GSMNP. The project goal is to investigate global, regional and/or local influences on stream health and food chain dynamics such as climate change and atmospheric deposition of mercury. Results (Olson et al. 2019) indicated no impairment from sediment, nutrients, organic compounds (e.g., pesticides), or metals except aluminum (Al). Drops in pH (aided by low natural alkalinity/hardness) and concurrent spikes in naturally occurring Al during high flow events can affect gas exchange at fish gills. Methylmercury levels were very low in aquatic insects (trichopterans) and water striders (*Gerris*), as well as Brook Trout and Rainbow Trout. Whole-body methylmercury levels in trout from Gentry Creek and three other streams in the CNF (Left prong Hampton Creek and Bald River) and GSMNP (Rock Creek) averaged 0.037 ± 0.003 µg/kg (Olson et al. 2019). Interestingly, methylmercury levels in tetragnathid spiders, which build webs above the stream surface to catch emerging insects, can be very high.

Management Recommendations

Gentry Creek supports a quality wild trout fishery featuring Brook Trout that management should maintain and emphasize. Continued monitoring at the Gentry Creek station will be important to further understand Brook and Rainbow Trout interactions in sympatry (particularly their responses to droughts and floods) and to gauge the ability of Rainbow Trout to replace Book Trout. It is recommended that no efforts to removed Rainbow Trout or enhance Brook Trout be initiated in Gentry Creek while this monitoring is underway so that only natural processes can be studied.

Table 2-16. Site and sampling information for Gentry Creek in 2018.

Location	**Station 1**	
Site code	420181501	
Sample date	19 June	
Watershed	S. Fork Holston River	
County	Johnson	
Quadrangle	Grayson 219 SW	
Lat-Long	36.55928 N, -81.71131 W	
Reach number	06010102-27,0	
Elevation (ft)	3,180	
Stream order	2	
Land ownership	USFS	
Fishing access	Excellent	
Description	This monitoring station ends at the eighth crossing by the adjacent trail (beginning at the parking area near Cut Laurel Branch).	
Effort		
Station length (m)	122	
Sample area (m²)	464	
Personnel	5	
Electrofishing units	1	
Voltage (AC)	350	
Removal passes	3	
Habitat		
Mean width (m)	3.8	
Maximum depth (cm)	NM	
Canopy cover (%)	90	
Aquatic vegetation	scarce	
Estimated % of site in pools	40	
Estimated % of site in riffles	60	
Habitat assessment score	166 (optimal)	
Substrate Composition	**Pool (%)**	**Riffle (%)**
Silt	5	5
Sand	15	30
Gravel	35	40
Rubble	25	20
Boulder	15	5
Bedrock	5	0
Water Quality		
Flow (cfs; visual)	3.04; NORMAL	
Temperature (C)	16.9	
pH	6.7	
Conductivity (µS/cm)	18	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	10	

Table 2-17. Fish population abundance estimates (with 95% confidence limits) for the monitoring station on Gentry Creek sampled 19 June 2018.

Species	Total Catch	Population Size Est.	Population Size Lower C.L.	Population Size Upper C.L.	Est. Weight (g)	Mean Fish Wt. (g)	Biomass (kg/ha) Est.	Biomass (kg/ha) Lower C.L.	Biomass (kg/ha) Upper C.L.	Density (fish/ha) Est.	Density (fish/ha) Lower C.L.	Density (fish/ha) Upper C.L.
RBT ≤90 mm	7	7	7	13	5	0.8	0.11	0.12	0.22	151	151	280
RBT >90 mm	3	3	3	11	209	69.6	4.50	4.50	16.50	65	65	237
BKT ≤90 mm	18	18	18	21	55	3.1	1.19	1.20	1.40	388	388	453
BKT >90 mm	11	11	11	14	441	40.1	9.50	9.51	12.10	237	237	302
Mottled sculpin	42	50	42	65	381	7.6	8.21	6.88	10.65	1,078	905	1,401
Totals	**81**	**89**	**81**	**124**	**1,091**		**23.51**	**22.21**	**40.87**	**1,918**	**1,746**	**2,672**

Note: RBT = Rainbow Trout; BKT = Brook Trout.

Gentry Creek

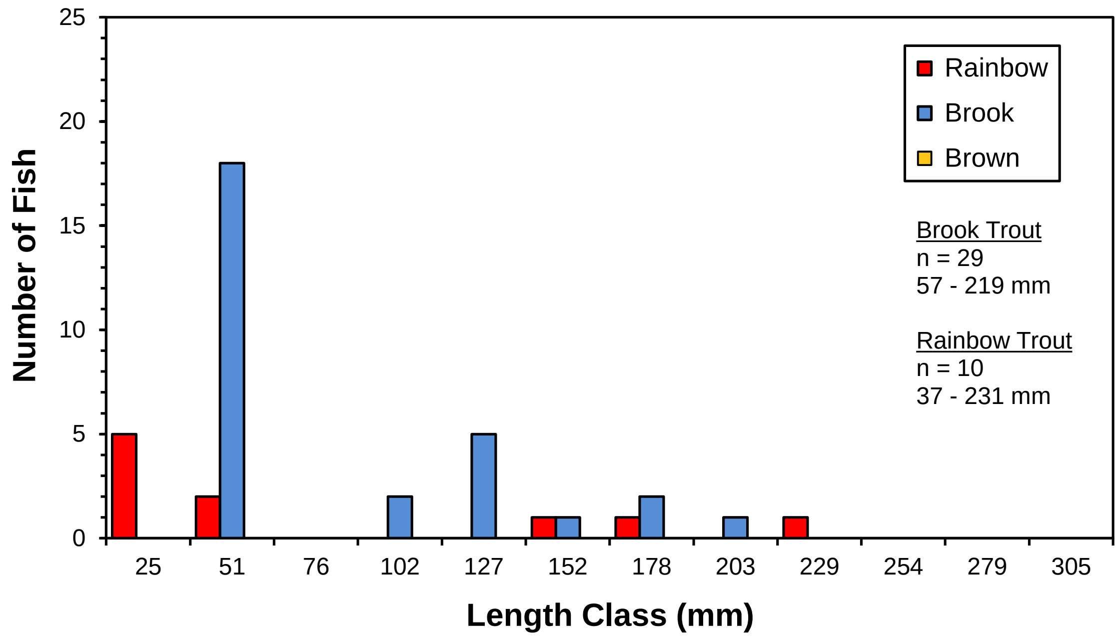


Figure 2-16. Length frequency histogram for Brook Trout and Rainbow Trout from the 2018 Gentry Creek Sampling.

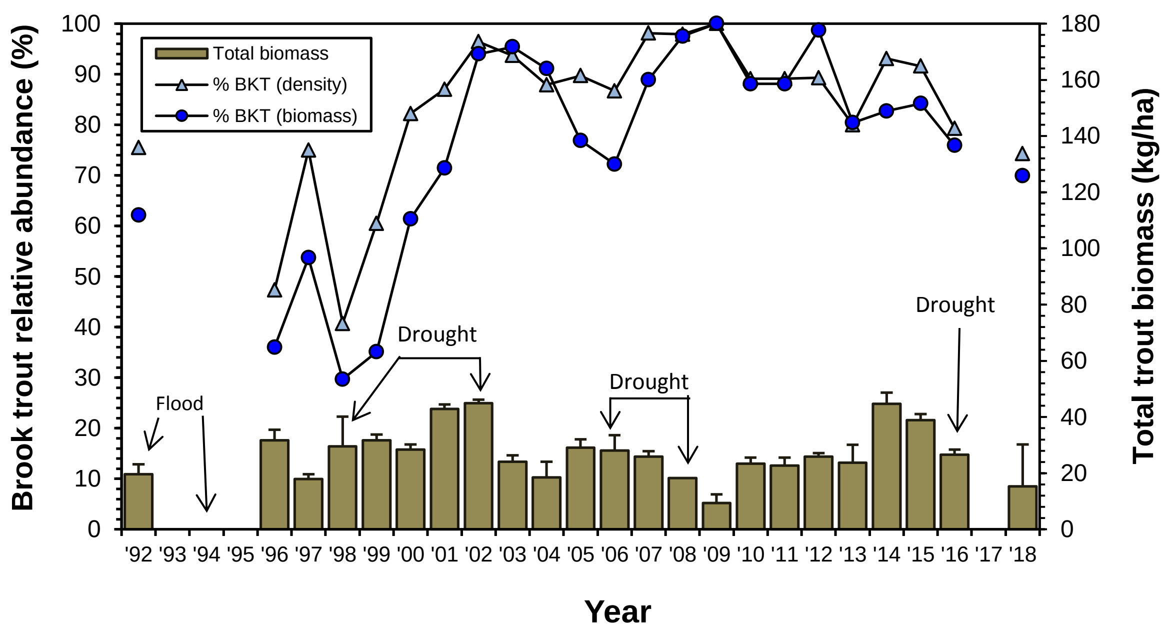


Figure 2-17. Total biomass and relative Brook Trout abundance at the Gentry Creek monitoring station. Bars indicate upper 95% confidence limits.

2.9.4 Rocky Fork

Study Area

Rocky Fork is a tributary of South Indian Creek in the Nolichucky River basin and is located within Greene and Unicoi counties. The watershed is mountainous and forested, with some recent (although limited) logging activity. The lower portion of the stream is contained within the 825-ha (2,036-acre) Lamar Alexander Rocky Fork State Park. Planning continues for development of the Park's access roads, trail system, welcome center, picnic shelters, and campground. The remaining 3,000 ha (7,600 acres) of the formerly privately-owned Rocky Fork tract were added to the CNF. The middle and lower reaches of Rocky Fork support an excellent wild Rainbow Trout population. The upper portion (above 2,890') has both Brook and Rainbow Trout. Three tributaries (Blockstand Creek, Broad Branch, and Fort Davie Creek) also contain Brook Trout populations. Genetically, all four populations (including Rocky Fork) have substantial hatchery influence from numerous stockings that occurred into the 1980s (Strange and Habera 1997). New DNA samples were collected from each population in 2016 to evaluate current genetic characteristics, but results are still pending.

Shields (1950) noted that Rainbow Trout growth and production in Rocky Fork was quite good and described the portion from Fort Davie Creek downstream (12.9 km) as carrying a large crop of fish. Despite the Rocky Fork's capacity for wild trout production, it was intensively managed as a put-and-take fishery with hatchery-produced Rainbow and Brook Trout for many years (Bivens et al. 1998). That strategy was changed in 1988 to feature wild trout by discontinuing stocking except in the 1.7-km segment upstream of the confluence with South Indian Creek. The stocking rate for that portion of Rocky Fork averages ~4,800 adult Rainbow Trout per year. A three-trout creel limit was also added to the 229-mm minimum length limit to the single-hook, artificial-lures only regulations already in place. Regulations were changed again in 1991 to focus harvest on Rainbow Trout by removing their size limit and raising the creel limit to seven trout (to include only three Brook Trout). Subsequently, as more data from Rocky Fork and other wild trout streams have become available, regulations were changed again in 2013 to make them more biologically relevant. Accordingly, the creel limit was increased to five fish and minimum size limits were removed (including the 152-mm statewide size limit for Brook Trout).

TWRA qualitatively sampled Rocky Fork in the 1980s (Bivens 1989; Bivens and Williams 1990), which then led to the current quantitative sampling program in 1991 with the establishment of two long-term monitoring stations. These stations have been sampled annually since 1991. Site location and effort details, along with habitat and water quality information are summarized in Table 2-18. Only Station 2 (sympatric Brook/Rainbow Trout monitoring program) was sampled in 2018 because of frequent high flows.

Results and Discussion

Catch and abundance estimates for trout sampled at Station 2 on Rocky Fork in 2018 are given in Table 2-19. Length-frequencies for Rainbow Trout and Brook Trout (Figure 2-18) indicate somewhat better age-0 cohorts compared to 2017, despite potentially lower capture efficiency associated with higher flow during the 2018 sampling effort (16 cfs vs. 2 cfs in 2017). No Brook

Trout >178 mm were present in 2018 (Figure 2-18), although two were present in 2017. Nagel and Deaton (1989) questioned the size advantage Rainbow Trout were thought to hold over Brook Trout in Rocky Fork's headwaters (Whitworth and Strange 1983) and elsewhere. However, monitoring data from Rocky Fork and other streams have generally verified the tendency of Rainbow Trout to grow larger than Brook Trout in a variety of sympatric situations. This advantage may be lost at times during droughts such as in 2008 (Habera et al. 2009) and 2016 (Habera et al. 2017), when survival and recruitment appear to be impacted more for Rainbow Trout than for Brook Trout. Total trout abundance decreased from 2017 (Figure 2-19), likely due to low capture efficiency during this high water sampling event.

Brook Trout relative abundance (biomass) was quite stable at about 40% from 1991 through 1993, but declined rapidly after the flood in early 1994 (Figure 2-19) and associated Brook Trout year-class failure (Strange and Habera 1995). Brook Trout relative abundance recovered to the pre-flood level in 1996, then surpassed 50% in 2000 and 60% in 2001 (Figure 2-19 during the dry years of 1998-2002 (Habera et al. 2003). Brook Trout relative abundance (biomass) generally increased again with the next drought, surpassing 60% in 2015 and 2016 (Figure 2-19). In fact, Brook Trout relative abundance (biomass) in 2015 and 2016 was the highest observed at that time, but has fallen into the 40% range in 2017 and 2018 (Figure 2-19). It is clearly evident in Rocky Fork (and elsewhere) that Brook Trout can exist—and even thrive—in sympatry with Rainbow Trout for long periods of time under variable environmental conditions. Brook Trout appear to be favored during droughts in the sense that competitive pressure is reduced as Rainbow Trout are more negatively impacted. However, cumulative drought effects on recruitment may reach a level where the abundance of both species is reduced to the point that relative abundance percentages have little meaning. This occurred in Briar Creek in 2009-2011, Gentry Creek in 2018, Rocky Fork in 2010, and Birch Branch in 2008-2010.

Management Recommendations

Upper Rocky Fork continues to provide an example of the resiliency of wild trout populations (particularly Brook Trout) in southern Appalachian streams. Despite large reductions in abundance related to droughts and floods, the Brook Trout population has demonstrated the ability to recover, even in the presence of Rainbow Trout. Future management should protect and emphasize this important fishery. Annual monitoring should continue at Station 2 to further develop our understanding of sympatric Brook and Rainbow Trout interactions and assess the ability of Rainbow Trout to replace Brook Trout over time. It is recommended that no efforts to removed Rainbow Trout or enhance Brook trout be initiated in upper Rocky Fork while this monitoring is underway so that only natural processes can be studied.

Table 2-18. Site and sampling information for Rocky Fork in 2018. Station 1 was not sampled due to high flow.

Location	Station 1		Station 2	
Site code	420182801		420182802	
Sample date	20 September		20 September	
Watershed	Nolichucky River		Nolichucky River	
County	Unicoi		Greene	
Quadrangle	Flag Pond 190 SE		Flag Pond 190 SE	
Lat-Long	36.04801 N, -82.55889 W		36.06758 N, -82.59608 W	
Reach number	06010108		06010108	
Elevation (ft)	2,360		3,230	
Stream order	4		3	
Land ownership	State of TN (TDEC)		USFS	
Fishing access	Good		Limited	
Description	Begins ~100 m upstream of the blue gate.		Ends ~10 m upstream of confl. with Ft. Davie Ck.	
Effort				
Station length (m)	130		100	
Sample area (m^2)	NA		680	
Personnel	NA		4	
Electrofishing units	NA		1	
Voltage (AC)	NA		600	
Removal passes	NA		3	
Habitat				
Mean width (m)	NA		6.8	
Maximum depth (cm)	NA		80	
Canopy cover (%)	NA			
Aquatic vegetation	NA		scarce	
Estimated % of site in pools	NA			
Estimated % of site in riffles	NA			
Habitat assessment score	NA			
Substrate Composition	Pool (%)	Riffle (%)	Pool (%)	Riffle (%)
Silt	NA			
Sand	NA			
Gravel	NA			
Rubble	NA			
Boulder	NA			
Bedrock	NA			
Water Quality				
Flow (cfs; visual)	NA		16.2; high	
Temperature (C)	NA		15.2	
pH	NA		6.8	
Conductivity (μS/cm)	NA		7.0	
Dissolved oxygen (mg/L)	NA		N/M	
Alkalinity (mg/L $CaCO_3$)	NA		N/M	

Table 2-19. Fish population abundance estimates (with 95% confidence limits) for the monitoring stations on Rocky Fork sampled 20 September 2018. Station 1 not measured due to high water.

		Population Size			Est.	Mean	Biomass (kg/ha)			Density (fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Weight (g)	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
Station 2												
RBT ≤90 mm	13	14	14	21	48	3.4	0.70	0.70	1.05	206	206	309
RBT >90 mm	10	10	10	15	477	47.7	7.01	7.01	10.52	147	147	221
BKT ≤90 mm	10	10	10	14	42	4.2	0.62	0.62	0.86	147	147	206
BKT >90 mm	11	11	11	15	305	27.7	4.48	4.48	6.11	162	162	221
Totals	**44**	**45**	**45**	**65**	**871**		**12.81**	**12.81**	**18.55**	**662**	**662**	**956**

Note: RBT = Rainbow Trout and BKT = Brook Trout.

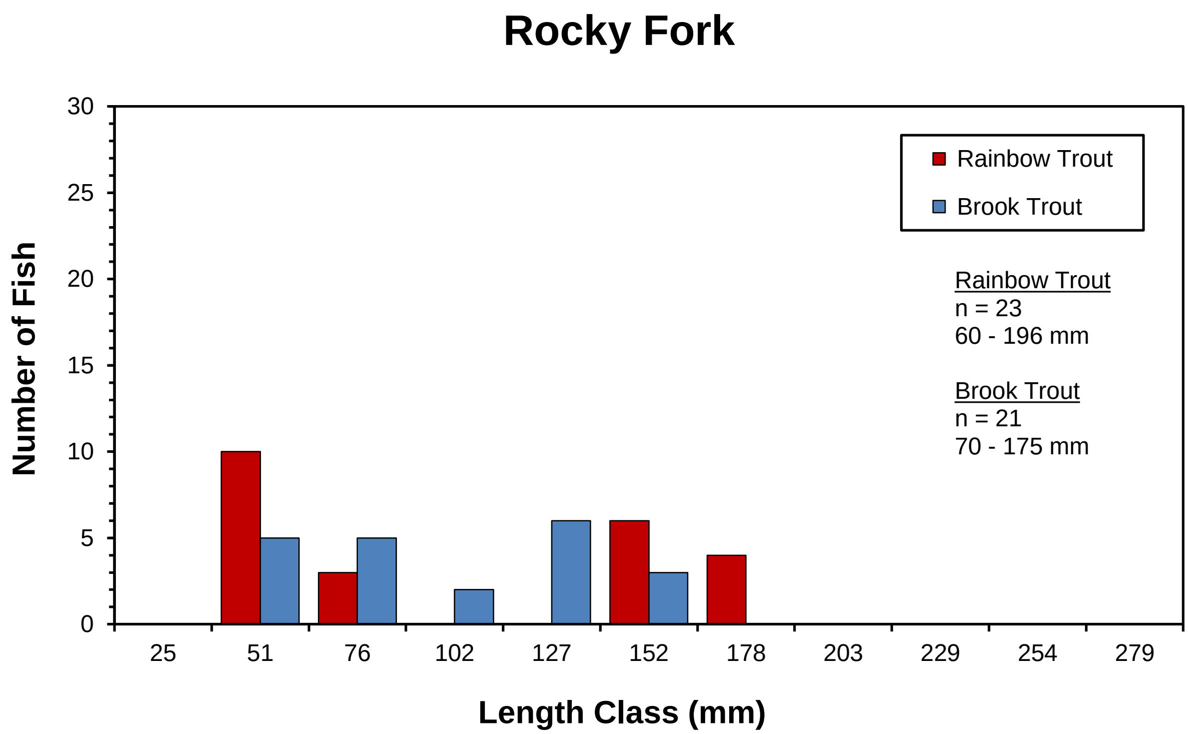


Figure 2-18. Length frequency distributions for Brook and Rainbow Trout from the 2018 sample at the upper monitoring station (2) on Rocky Fork.

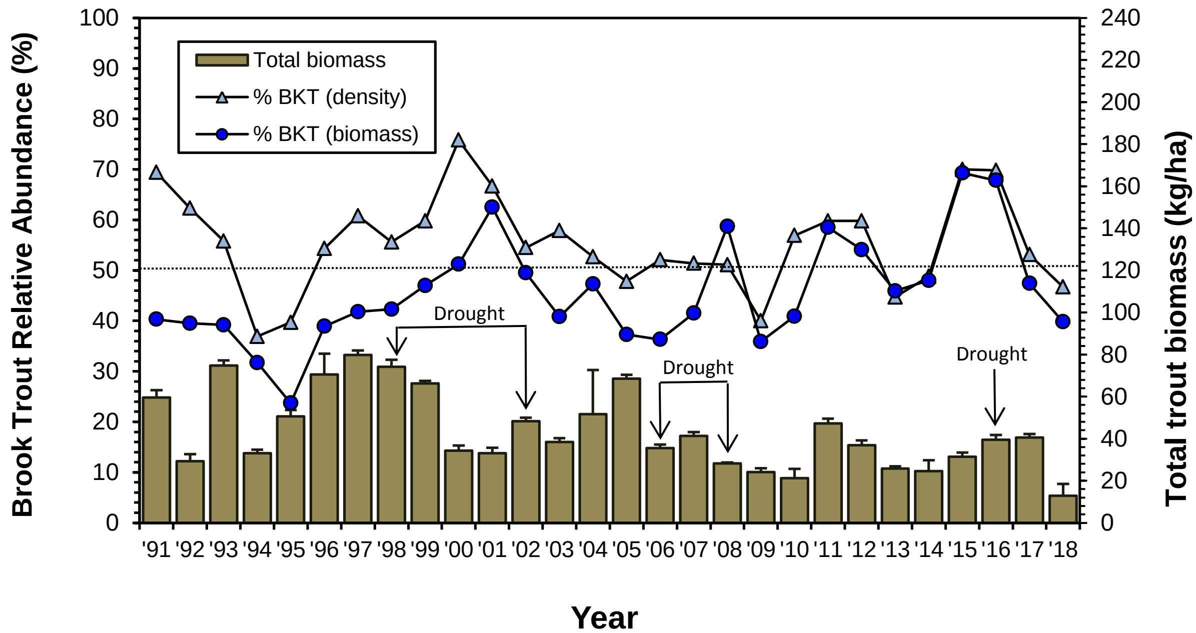


Figure 2-19. Total biomass and relative Brook Trout abundance at the upper monitoring station (2) on Rocky Fork. Bars indicate upper 95% confidence limits.

2.9.5 Summary

Most southern Appalachian coldwater streams historically had Brook Trout, but they have been eliminated from many of these streams for various reasons, including widespread introduction of Rainbow Trout in the early 20th century. Currently, four streams with wild Brook Trout and Rainbow Trout are being monitored long term with the objective of documenting how (or if) Rainbow Trout replace Brook Trout.

Clark and Rose (1997) recognized conventional theory—a niche shift induced by the presence of a superior competitor—did not explain replacement of Brook Trout by Rainbow Trout. Their modeling emphasized the importance of year-class failures (e.g., those caused by floods), but predicted that Rainbow Trout would not replace Brook Trout if such failures occurred infrequently (intervals of 10-20 years). Even with much more frequent year-class failures (3-year intervals), it still required 80 years for a simulated Brook Trout population to be eliminated. Simulated year-class failures included both species, even though typical late-winter/early-spring floods could impact year-class strength of Brook Trout (fall spawners) much more severely than Rainbow Trout (Strange and Habera 1995, 1996; Warren et al. 2009). Additionally, these and subsequent (Clark et al. 2001) model simulations did not include droughts, which can be frequent and are clearly more detrimental to Rainbow Trout survival and recruitment in sympatric Tennessee populations. However, both floods and droughts would be expected to occur over several decades and their effects on relative abundance can be offsetting.

Many studies have observed long-term density fluctuations of native and introduced trout, but not total elimination of the native trout (e.g., Larson et al. 1995; Adams et al. 2002). However, larger and longer-lived Brown Trout have been shown to limit Brook Trout growth, recruitment, and abundance (Hoxmeier and Dieterman 2013; 2016) or essentially replace them (Waters 1999) in Minnesota streams. Complete replacement of Brook Trout by Rainbow Trout in Tennessee streams might be possible only through unusual circumstances, such as a succession of late winter/early spring floods or drought that severely weaken or eliminate multiple Brook Trout year classes. Conversely, data from all four monitoring streams indicate that droughts, particularly where conditions were less severe during fall and early spring (e.g., 1998-2002 and 2006-2008), can offset Brook Trout declines by reducing Rainbow Trout relative abundance. Extended drought, however, may eliminate Brook Trout populations in marginal habitats regardless of the presence of any sympatric salmonids (Habera et al. 2014a).

Although Brook Trout relative abundance has fluctuated over the years at the monitoring stations, it appears that Rainbow Trout have no particular competitive advantage, thus these species can coexist for many years at some general equilibrium. Strange and Habera (1998) and Habera et al. (2001a; 2014a) found no broad-scale loss of distribution or inexorable replacement by Rainbow Trout in sympatric populations. Furthermore, Brook Trout have gained distribution (2 km or more in some cases) in the presence of Rainbow Trout in several streams since the 1990s (Habera et al. 2014a). Additional monitoring data will be useful for identifying any conditions that may eventually enable Rainbow Trout to eliminate Brook Trout. These could include landscape alterations (Hudy et al. 2008; Stranko et al. 2008) and climate change (Trumbo et al. 2010; Myers et al. 2014; DeWeber and Wagner 2015). Interestingly, Trumbo et al. (2010) found that their direct measurement of paired air and water temperatures in Virginia identified more Brook Trout watersheds that would be resistant to predicted air temperature increases—and with potential refugia existing at lower elevations—than predicted by previous modelling. Additionally, Stitt et al. (2014) found that among Brook Trout strains, thermal tolerance was highest for the one with the most southern ancestry. Verhille et al. (2016) observed the same characteristic for wild Rainbow Trout at the southern limit of distribution within their native range. This would potentially provide Brook Trout additional flexibility for adjusting to changing climatic conditions and some resistance to replacement by Rainbow Trout in thermally stressed environments. In mainstem habitats, competition for thermal refugia, rather than food, is likely more important for Brook Trout and would be heightened under current climate change scenarios, especially in the presence of exotic salmonids (Huntsman and Petty 2014). Water temperature monitoring data could help explain Brook Trout and Rainbow Trout abundance trends in Tennessee streams, thus temperature loggers will be deployed in selected streams in 2020 to obtain this information.

2.10 NATIVE BROOK TROUT RESTORATION AND ENHANCEMENT PROJECTS

TWRA and the USFS cooperatively developed, as part of the Tennessee Native Brook Trout Management Plan (Habera 2017), a list of native Brook Trout restoration and enhancement projects for 2017-2027. These projects are organized into two groups (tiers). Tier 1 projects (highest priority) involve restoring native Brook Trout populations in streams with suitable habitat by completely removing any existing nonnative trout populations (Table 2-20). Tier 2 projects (Table 2-21) are generally lower priority, but provide opportunities to get native Brook Trout back into streams/watershed where they have been long absent and would be managed as sympatric populations unless enhancement become feasible. Restorations involve re-establishing an allopatric native Brook Trout population and maintaining it as such. Enhancement projects remove Rainbow Trout from an existing sympatric native Brook Trout population and may extend Brook Trout distribution downstream to a natural barrier. Restoration and enhancement projects underway in 2018 are summarized below.

Table 2-20. Potential Tier 1 Brook Trout restoration and enhancement projects in Region 4.

Stream	Watershed	Species present	Barrier	Start elevation	Length (miles)	Comments	Current status
Green Mountain Branch	South Fork Holston	RBT	Yes	3,130	1.0	Barrier located and moved to Tier 1	Complete RBT removal and introduce BKT in 2019
Little Jacob Creek	South Fork Holston	RBT/BKT	Yes	2,270	1.0	Monitor for Brook Trout survival	Complete; begin monitoring phase
Phillips Hollow	Nolichucky	None	Yes (2)	2,230	0.6	Fish to be acquired from NC	In progress; identify source populations in NC
Little Paint Creek	French Broad	None	Yes	2,000	1.5	Use fish from Gulf Fork tribs.	Not in progress
Devil Fork	Nolichucky	RBT	Yes (3)	1,900	0.5	Restore between lower 2 falls; no fish above 2nd	Not in progress
Trail Fork Big Creek	French Broad	RBT	Yes	TBD	TBD	Use fish from Gulf Fork tribs.	Complete RBT removal and introduce BKT in 2019
Jennings Creek	Nolichucky	RBT	TBD	TBD	TBD	Use fish from Phillips Hollow; account for Round Knob Branch	Not in progress
Horse Creek	Nolichucky	RBT	TBD	TBD	TBD	Remove RBT if barrier exists; otherwise move to Tier 2	Not in progress

Table 2-21. Potential Tier 2 Brook Trout re-introduction projects in Region 4.

Stream	Watershed	Species present	Barrier	Start elevation	Length (miles)	Comments	Current status
Sinking Creek	Watauga	RBT/BNT	No	2,060	1.3	Initially thin RBT/BNT; include Basil Hollow tributary	No barrier present; check downstream for end of trout distribution in 2019
Upper Granny Lewis Creek	Nolichucky	RBT	No	2,800	1.0	Initially thin Rainbows	Not in progress
Right Prong Rock Creek	Nolichucky	RBT	No	2,220	1.7	Initially thin Rainbows	Potential barrier found; initiate removal in 2020

2.10.1 Little Jacob Creek

Native Brook Trout were reintroduced to Little Jacob Creek—a South Holston Lake tributary on the CNF in Sullivan Co.—in September 2000 by translocating 180 fish from Fagall Branch, Heaberlin Branch, and East Fork Beaverdam Creek (Habera et al. 2001b). All three source populations are Beaverdam Creek tributaries in the South Fork Holston River watershed. Brook Trout were released into the 970-m stream reach between 756 m and 817 m elevation without removing the existing wild Rainbow Trout population in this area (2,735 fish/ha; 31 kg/ha). Successful Brook Trout reproduction was verified in August 2001 (22 age-0 fish collected) and again in August 2003, with Brook Trout considered successfully established in Little Jacob Creek at that time (Habera et al. 2004).

All size classes of Brook Trout were present in the introduction zone in a 2010 survey. A cascade series suitable as a barrier was located in 2011 at 689 m (2,260'), thus permitting conversion of the 1.6-km reach upstream to allopatric native Brook Trout. Brook Trout distribution in Little Jacob Creek was 1.2 km in 2011, although most of it was shared with Rainbow Trout.

Extremely low stream flows in 2016 provided an excellent opportunity to enhance the Little Jacob Creek Brook Trout population and extend it down to the cascade barrier by removing sympatric Rainbow Trout (by electrofishing) throughout the 1.6 km upstream reach. Rainbow Trout removal efforts were extended downstream to the culvert at the USFS road (FR 4002) crossing in 2017, adding an additional 300 m to the enhancement project. A June 2018 electrofishing survey produced only a few adult Rainbow Trout and no age-0 fish in this lower 300-m reach, indicating the stream was ready for Brook Trout translocation. Pre-spawn Brook Trout from the original source streams (Fagall Branch, n = 70; Heaberlin Branch, n = 12; E. Fork Beaverdam Creek, n = 30) were collected in late September 2018 and translocated to lower Little Jacob Creek. Most (~80) of these fish were distributed between the road crossing and the cascade, while the rest were released in the 100 m reach above the cascade to supplement the Brook Trout population there.

Periodic monitoring will be conducted to determine effectiveness of the culvert as a barrier and establishment of Brook Trout downstream of the cascade. Also, there may be a barrier downstream of the culvert that could permit further downstream extension of the Brook Trout population. Temperature loggers will also be deployed within the next five years to monitor water temperatures during the summer months.

2.10.2 Little Stony Creek

A native Brook Trout restoration project was initiated in Little Stony Creek during fall 2014 (Habera et al. 2015a). Little Stony Creek is a tributary to Watauga Lake in Carter County (Figure 2.20). Its headwaters flow from Pond Mountain and Walnut Mountain in the Pond Mountain Wilderness Area. Except for small segments at its upper and lower ends, the entire stream is located within the CNF. Previous accounts of Little Stony Creek (Shields 1950; Tatum 1968) did not mention Brook Trout, although they would have occurred there historically. The basic plan for this restoration project was to evaluate current Rainbow Trout distribution, remove Rainbow Trout through intensive backpack electrofishing, reintroduce native Brook Trout from Left Prong Hampton Creek, and monitor their establishment. During 2014-2017 Rainbow Trout were removed from the 1.4-km reach between the cascade barrier at 732 m (2,400’) and another cascade barrier at 841 m (2,760’), as well as the lower 0.35 km the Maple Springs Branch tributary (Habera et al. 2018a).

Native Brook Trout propagated at the Tennessee Aquarium Conservation Institute (TNACI) from adults collected from Left Prong Hampton Creek were stocked in 2014, 2015, and 2018. Stocking in 2015 included the area upstream of the upper cascade barrier (no trout were present) and Brook Trout subsequently became established there (Habera et al. 2018a). Given that Brook Trout abundance in the lower portion of the Little Stony Creek restoration area remains low (primarily because of low initial stocking densities), a supplemental stocking is necessary there to complete the project. Additional Brook Trout were captured from Left Prong Hampton Creek in August of 2018 to be spawned at TNACI and their progeny will be released in lower restoration area in May 2019.

A check for any remaining Rainbow Trout in the lower 800 m of the restoration zone should be made in 2019, followed by quantitative sampling at the monitoring site in this reach during 2020 and periodically thereafter. Instream temperature loggers might also be deployed within the next five years to monitor water temperatures, particularly during the summer months.

2.10.3 Green Mountain Branch

A 2006 qualitative survey of this Beaverdam Creek tributary (Johnson Co.) indicated the presence of a relatively abundant wild Rainbow Trout population at 3,080’ along Hwy. 421 east of Shady Valley. Although this is a smaller stream (~2 m) wide), it has above average fertility and relatively good habitat., making this originally a Tier 2 stream, with the potential to be transitioned into a Tier 1 stream if a barrier was found.

This stream was qualitatively surveyed in 2018 to check for a barrier and assess the fish population. A potential barrier was located upstream of the Sluder Road crossing on private land at ~3,100’ (see photo) and about 200 m downstream of the CNF boundary. Therefore, Green

Barrier on Green Mountain Branch with Austin Archer (TWRA intern).

Mountain Branch was elevated to a Tier 1 stream, and Rainbow Trout removal work began in preparation for restoring native Brook Trout.

Nearly all of the restoration area lies within the CNF and TWRA partnered with the USFS to cut trails and remove overhanging *Rhododendron* from the stream to facilitate the restoration project. Two electrofishing passes were made through 2.91 km of stream (2.74 km main channel and 0.17 km tributary) in 2018, resulting in the removal of 507 age-0, 55 sub-adult (100-150 mm), and 66 adult Rainbow Trout.

Plans for 2019 are to remove any remaining adult Rainbow Trout and, if no age-0 fish are found, (indicating no reproduction occurred), introduce pre-spawn Brook Trout in September. These will be obtained from Beaverdam Creek tributaries such as Fagall Branch, Heaberlin Branch, and East Fork Beaverdam Creek.

2.10.4 <u>Phillips Hollow</u>

This stream is in the Dry Creek watershed in Greene Co. and is now fishless above a barrier at 2,230’, likely as the result of Rainbow Trout removal efforts conducted during low flow in 1991. It will be used to restore native Brook Trout in the Nolichucky River basin in Tennessee (which are now extirpated). Native Nolichucky-basin Brook Trout do currently exist in North Carolina, and TWRA and North Carolina Wildlife Resources Commission (NCWRC) representatives met in October 2018 to discuss potential sources for translocation to Phillips Hollow. Elk Hollow, Jones Creek, Pyatt Creek, and Spring Creek in the North Toe River system were identified and will require whirling disease and gill lice screening before fish can be moved. Additional genetics information for Jones Creek should also be available in early 2019. Once the disease screening and genetics information are available, TWRA and NCWRC will make a joint decision on where to obtain fish for Phillips Hollow and how many can be provided. If this can be done prior to September, then translocation to Phillips Hollow can proceed in 2019.

2.10.5 <u>Trail Fork of Big Creek</u>

Upper Trail Fork of Big Creek (Cocke Co.) and its tributaries between 2,680’ and 3,190’ provide an opportunity for a cooperative native Brook Trout restoration project with the USFS and private landowners on a larger stream system that includes some third-order habitat. A large double waterfall (35.83382 N, -82.96238 W) suitable as barrier to the downstream Rainbow Trout population was located on a private inholding ~200 m below the Lemon Prong confluence. That landowner approved of the project and granted access in 2018, as did another with an inholding further upstream in the Trail Fork restoration zone. Rainbow Trout removal began during the summer of 2018 and 519 (354 age-0; 115 sub-adults; 50 adults) were removed by electrofishing throughout the 3.5-km restoration area (primarily with two passes). This total includes 61 fish (37 age-0; 12 sub-adults; 12 adults) from the lower 0.28 km of Lemon Prong that held trout (the portion below the road crossing). Rattlesnake Branch had no fish.

The Trail Fork Big Creek watershed (Cocke Co).

Plans for 2019 are to complete the removal of the Rainbow Trout population within the restoration zone. This should be possible if no spawn occurred and would be indicated by the lack of age-0 fish in 2019. If Rainbow Trout removal is complete by September 2019, pre-spawn native Brook Trout could then be translocated to Trail Fork. These would likely come from populations in the Gulf Fork of Big Creek (Brown Gap Creek and Middle Prong Gulf Creek) or GSMNP streams (e.g., Cosby Creek) with cooperation from the NPS.

2.10.6 <u>Sinking Creek</u>

This stream (Watauga River tributary in Washington Co.) has a wild Rainbow and Brown Trout population, but seven Brook Trout (six sub-adults; one adult) were captured in 2006 within a 1.2-km reach between 2,020’ and 2,140’. However, a follow-up survey in 2007 was unable to relocate any Brook Trout in Sinking Creek or Basil Hollow (a headwater tributary), and none were found in a 2018 qualitative survey. There is no other documentation of Brook Trout occurring in Sinking Creek or being stocking there, and it is uncertain why they were not found in 2007. This is a larger stream with good access along Dry Creek Rd. and no riparian development. It has suitable wild trout habitat that would provide an excellent opportunity to reintroduce native Brook Trout to a Watauga River subwatershed where they have been extirpated (Eastern Brook Trout Joint Venture assessment). There are no fish passage barriers on this stream (Tier 2), so Rainbow and Brown Trout in upper Sinking Creek could be thinned from about 2,000’ up to the Horse Cove area (including the Basil Hollow Tributary). Native Brook Trout from the Watauga watershed (e.g., Left Prong Hampton Creek) could then be translocated to this reach. Further assessment downstream of 2,000’ is needed to determine where Rainbow Trout distribution begins and if any potential fish barriers exist in that area. About 160 m of the portion of Sinking Creek upstream of 2,000’ is on the CNF; the remainder flows through four privately-owned parcels and the consent of those landowners would be necessary to proceed with this project.

2.10.7 Right Prong Rock Creek

Potential fish passage barrier on (Rt. 395 crossing) on R. Prong Rock Creek with Austin Archer (TWRA intern).

Right Prong Rock Creek (Rock Creek/Nolichucky River tributary in Unicoi Co.) once had Brook Trout, but now supports only wild Rainbow Trout. It is considered a Tier 2 stream (no fish passage barrier), but qualitative surveys during the summer of 2018 indicated that the Hwy. 395 crossing at ~2,450' (large box culvert with perch downstream outlet; see photo) might be modified to make it an effective barrier. A unnamed tributary that enters Right Prong Rock Creek ~140 meters downstream has a similar potential barrier where it is crossed by Hwy. 395 (see photo). No fish were found in the tributary during the 2018 survey, but it might be capable of supporting trout. Rainbow Trout and Blacknose Dace were found in the mainstem upstream of the potential box culvert barrier.

Potential fish passage barrier (Rt. 395 crossing) on unnamed tributary of R. Prong Rock Creek with Austin Archer (TWRA intern).

The next steps for a potential Right Prong Rock Creek restoration project would be to determine the feasibility of modifying the channel below the perched box culvert to make it an effective fish passage barrier and to identify the upper distributional limit of Rainbow Trout. Currently, there are no native Brook Trout populations in Nolichucky basin streams in Tennessee, so completion of this project would ultimately depend upon establishing the Phillips Hollow population (Section 2.10.4).

3. TAILWATER ACCOUNTS

Region IV's tailwater trout fisheries present unique fishery management problems and opportunities for which no standard solutions or practices apply (Hill 1978). The problems inherent in sampling tailwaters, such as their large size, fluctuating flows, and the lack of any practical means for maintaining closed populations, make it difficult at best to collect quantitative data from these systems. Additionally, natural reproduction is typically insignificant, so most tailwater trout populations are also largely hatchery-supported, with abundances and size/age-class densities related to stocking rates. In two cases however (the South Holston and Wilbur tailwaters), natural reproduction is substantial, requiring a different set of management strategies. Annual tailwater monitoring in Region IV began in 1991 (Bivens et al. 1992), but the initial efforts (prior to 1999) provided limited information. Consequently, TWRA sponsored more intensive studies focusing on assessment of trout abundance, the fate of stocked fish, natural reproduction, movements, and angler use in the Norris, South Holston, and Wilbur tailwaters (e.g., Bettoli and Bohm 1997; Bettoli 1999; Bettoli et al. 1999; Bettinger and Bettoli 2000; Bettoli 2002; Bettoli 2003a; Bettoli 2003b; Hutt and Bettoli 2003; Meerbeek and Bettoli 2005; Bettoli 2006; Holbrook and Bettoli 2006; Bettoli 2007; Damer and Bettoli 2008).

3.1 SAMPLING METHODS AND CONDITIONS

Sampling effort for the Norris, Cherokee, South Holston, and Wilbur tailwaters annually consists of 600-s (pedal time) runs at each of 12 monitoring stations with boat-mounted electrofishing systems (120 pulses/s DC, 4-5 amps). The smaller Ft. Patrick Henry and Boone tailwaters are sampled using 900-s runs at 4 stations. Electrofishing on these tailwaters (except Norris) is conducted during the day with generation by one unit (turbine). Only trout are collected during these efforts. Tailwater sampling conditions and effort are summarized below:

Table 3-1. Tailwater sampling conditions and effort.

Tailwater	Year annual monitoring began	Sample time	Stations	Approximate flow	Total effort (h)
Norris	1999	Night	12	114 m^3/s (4,000 cfs)	2.0
Cherokee	2003	Day	12	114 m^3/s (4,000 cfs)	2.0
Ft. Patrick Henry	2002	Day	4	88 m^3/s (3,100 cfs)	1.0
Wilbur	1999	Day	13[1]	71 m^3/s (2,500 cfs)	2.0
Boone	2009	Day	4	88 m^3/s (3,100 cfs)	1.0
South Holston	1999	Day	12	71 m^3/s (2,500 cfs)	2.0

[1]An extra site was added in 2010 to help evaluate the Quality Zone; effort there (600 s) is not included in total effort.

3.2 TAILWATER MONITORING

Six Region IV tailwater trout fisheries (Norris, Cherokee, Wilbur, Ft. Patrick Henry, Boone, South Holston; Figure 1-1) are monitored annually. Management plans have been developed for the trout fisheries in the Norris (Habera et al. 2014a), Wilbur (Habera et al. 2015a), Boone/Ft. Patrick Henry (Habera et al. 2018b), and South Holston (Habera et al. 2015b) tailwaters. Sampling is conducted each year in late February or March (except Cherokee) to provide an assessment of the overwintering trout populations present before stocking begins. The Cherokee tailwater (Holston River) stations are sampled in the fall (October), as trout survival over the summer is a more important issue for that fishery. However, the Cherokee tailwater was also sampled in June 2018 to document trout abundance prior to the onset of the late summer/early fall water temperature bottleneck. Catch per unit effort (CPUE) for each species at each site (fish/h), as well as means for each tailwater, are calculated annually to monitor trout abundance trends. Annual monitoring samples have occasionally been cancelled (e.g., 2015 at Norris, 2008-09 at Wilbur, and 2008 at South Holston) because TVA was unable to provide the appropriate flows.

3.2.1 Norris (Clinch River)

Study Area

The Clinch River originates in southwestern Virginia and enters Tennessee in Hancock County. Norris Dam impounds the Clinch River 197 km (122 mi) downstream in Anderson County, forming 13,846-ha (34,213-acre) Norris Reservoir. Hypolimnetic discharges created coldwater habitat and rainbow trout were stocked in the tailwater shortly after completion of the dam in 1936 (Tarzwell 1939). The Tennessee Game and Fish Commission stocked trout during 1950-1970 and managed the river as a year-round fishery (Swink 1983). Chronic low dissolved oxygen levels and a lack of minimum flow limited development of the trout fishery (Boles 1980; Yeager et al. 1987) and were addressed by TVA's Reservoir Release Improvements Program (TVA 1980). Dissolved oxygen concentrations were improved initially by fitting the turbines with a hub baffle system (Yeager et al. 1987). Later (1995 and 1996), both turbines were replaced with a more efficient autoventing system (Scott et al. 1996), which maintains dissolved oxygen around 6 mg/L. A minimum flow of 5.7 m^3/s (200 CFS) was established in 1984 and has been maintained since then by a re-regulation weir located about 3.2 km (2 mi) downstream of the dam (Yeager et al. 1987). The weir was upgraded in 1995 to increase its holding capacity and improve public access (Bettoli and Bohm 1997).

Improvements in dissolved oxygen and minimum flows in the Norris tailwater increased the abundance and distribution of benthic invertebrates, as well as trout carrying capacity and trout condition (Yeager et al. 1987; Scott et al. 1996). The tailwater currently supports a popular 20-km (12.5-mi) fishery for Rainbow Trout, Brown Trout, and Brook Trout. Put-and-take and put-and-grow management is accomplished by annually stocking both fingerling and adult trout. Bettoli and Bohm (1997) documented a small amount of natural reproduction by rainbow trout, but recruitment to the tailwater fishery was considered to be minimal. Some of this natural reproduction may come from Clear Creek, which large rainbow trout enter to spawn each winter. Banks and Bettoli (2000) and Holbrook and Bettoli (2006) attributed the lack of Brown Trout reproduction in the Norris tailwater to poor or dewatered spawning substrate and unsuitable flows and water temperatures during spawning season. Some of these factors probably limit successful rainbow trout reproduction as well.

The first intensive study of the Norris tailwater trout fishery (1995-1997) produced an overwinter biomass estimate of 112 kg/ha composed of about 80% rainbow trout and 20% Brown Trout (Bettoli and Bohm 1997). Tennessee's only other tailwaters with higher trout biomass estimates at that time were South Holston and Wilbur (Bettoli 1999). Bettoli and Bohm (1997) also reported a relatively low return rate for stocked rainbow trout (19%) and very few Brown Trout were observed in the creel. Most adult (208-330 mm) rainbow trout cohorts stocked in the tailwater were found to be limited more by natural mortality than by angler harvest. Trout stocked as adults exhibited energetically inefficient behaviors (e.g., rapid, long-range movements) which led to poor creel-return rates and survival (Bettinger and Bettoli 2002). Consequently, the fishery is primarily supported by fingerling rainbow trout stocking (Bettoli and Bohm 1997; Bettinger and Bettoli 2000). High growth rates of fingerling-stocked rainbow trout (about 20 mm/month) allow the tailwater to produce quality-sized fish within a relatively short time (Bettoli and Bohm 1997). Growth of stocked Brown Trout is slower (12 mm/month; Meerbeek and Bettoli 2005).

The locations of TWRA's 12 monitoring stations on the Norris tailwater, sampled on 22 March 2018, are provided in Figure 3-1. Additional sample location and effort details are summarized in Table 3-1.

Results and Discussion

A 28 in., 8.6 lb. Brown Trout from the 2018 Norris tailwater sample.

The 2018 Norris tailwater sample produced 512 trout weighing nearly 170 kg (Table 3-2). The catch included 429 Rainbow Trout (84%), 65 Brown Trout (13%), and 18 Brook Trout (3%). No Brook Trout had been captured during 2016-2017 as none were available for stocking in 2015 and only 2,200 were stocked in 2016. The Rainbow Trout catch was the highest recorded to date and increased 11% relative to 2017 (Habera et al. 2018a). Brown trout catch was similar to 2017 (61) and has been relatively stable (50-65 fish/year) since 2013. Mean weight decreased 12% for Rainbow Trout (to 283 g/fish) and increased 11% for Brown Trout (to 695 g/fish) relative to 2017.

Rainbow Trout ranged from 153-507 mm, Brown Trout ranged from 180-720 mm, and Brook Trout ranged from 216-293 mm (Table 3-2). The large numbers of Rainbow Trout in the 102-, 127-, and 152-mm size classes present in 2017 (caused by the need to stock most of the 2017 fingerling allocation in November 2016) appear to have recruited well to the 203-, 229-, and 254-mm size classes (Figure 3-2) and may begin entering the 356-508 mm (14-20 in.) protected length range (PLR) by the 2019 monitoring sample. About 22% of Rainbow Trout and 31% of Brown Trout >178 mm were within the PLR (Figure 3-2). Additionally, five Brown Trout >508 mm were also captured. These larger fish were primarily present at stations 7-10 (Table 3-2).

The 2018 mean electrofishing catch rates for all trout ≥178 mm (254 fish/h), as well as for Rainbow Trout individually (213 fish/h) were the highest observed to date (Figure 3-3). The mean catch rate for Brown Trout ≥178 mm has remained relatively stable at 25-35 fish/h since 2012 (Figure 3-3). The increase in the Rainbow Trout (and overall) catch rates are likely transient and related to the stocking of about 73,000 extra fingerlings for the 2017 allocation year (133,000 in November 2016 and 100,000 in 2017; Habera et al. 2018a). The mean electrofishing catch rate for trout within the PLR (356-508 mm) was in the 70-80 fish/h range during 2014-2017, but declined somewhat to 56 fish/h in 2018 (Figure 3-3). This still achieves the mean PLR catch rate objective (28 fish/h) for the current Norris tailwater management plan (Habera et al. 2014a). Annual CPUE for trout ≥178 mm has been relatively stable (150-200 fish/h) and annual stocking rates have been relatively consistent, with the previously-noted exception of 2018. Therefore, increasing relative stock density for trout ≥356 mm or 14 in. (RSD-14) indicates that trout population size structures have been shifted toward larger fish since 2010 (Figure 3-4). An RSD-14 value of 50 indicates that 50% of all stock-size trout—those at least 254 mm (10 in.) in length—are 356 mm (14 in.) or larger and would be double the pre-PLR average of 25.

Typically, Norris has the highest trout stocking rate of any Tennessee tailwater (about 237,000/year). However, the stocking rate during calendar year 2018 was lower (89,000) to compensate for higher stocking rates of fingerling Rainbow Trout and adult Brook Trout in 2017 (Figure 3-5). Deteriorating water quality conditions at Dale Hollow National Fish Hatchery in November 2016 and again in 2017 made it necessary to stock much (133,000) of the 2017 fingerling Rainbow Trout allocation in November 2016 and all of the 2018 Brook Trout allocation in November 2017. The number of fingerling Rainbow Trout stocked in 2017 was reduced to compensate, but only to 100,000. Therefore, the actual fingerling stocking rate in 2017 exceeded the rate prescribed in the Norris tailwater management plan (160,000) by 73,000, so only 30,000 (mean length, 124 mm) were stocked in 2018 (Figure 3-5). Because the 2018 Brook Trout allocation (17,500, mean length 232 mm) was stocked in November 2017 (making a total of 37,500 that year), none were stocked in 2018 (Figure 3-5).

Roving creel surveys conducted by TWRA in 2015 (Black 2015), and 2017 (Black 2018) indicated that pressure and trips (Figure 3-6), along with catch and harvest (Figures 3-7 and 3-8) decreased over that two-year period. Pressure, catch, and harvest were also below the levels observed during the 2013 survey (Black 2014; Figures 3-6, 3-7, and 3-8). The average trout catch rate (fish/h) for 2017 was relatively similar to corresponding rates for 2013 and 2015 (Figure 3-7), and catch rates over 0.7 fish/h are generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). However, average catch per trip decreased by about 1 fish/trip from 2013 to 2017—mainly because trip length decreased (from 3.94 to 3.20 h). The overall trout harvest rate declined from the 23% in 2013 to 13% in 2017 (Figure 3-8) and has become similar to the most recent trout harvest rates for the South Holston (13%; Black 2018) and Wilbur (10%; Black 2017) tailwaters. The average number of trout harvested by Norris tailwater anglers has also decreased from 1 fish/trip in 2013 to about 1 fish/2 trips in 2017. Rainbow Trout represented the majority of catch (56-70%) and harvest (55-73%) during the previous three creel surveys, followed by Brown Trout and Brook Trout, although Brook Trout harvest exceeded that for Brown Trout in 2017. A new angler survey is underway on the Norris tailwater in 2019 and results will be available for inclusion in the 2020 report.

Because of the detection of *Myxobolus cerebralis*, the parasite that causes whirling disease, in the South Fork Holston and Wilbur tailwaters in 2017, trout from the Norris tailwater were examined in 2018. Fingerling Rainbow Trout from the weir dam area (45) and Llewelyn Island (23) were collected in August and screened by the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University. Results were negative. Interestingly, several of the fish collected at both sites were considerably smaller than 125 mm (size of the fingerlings stocked in May 2018) and appeared to be the result of natural reproduction.

Management Actions and Recommendations

TWRA's management goal for the Norris tailwater focuses on maintaining the quality trout fishery that has developed there since 2008 (Habera et al. 2014a). Accordingly, the primary strategy for attaining this goal is to maintain the abundance of quality-sized (≥356 mm or 14 in.) trout through the 356-508 mm (14-20 in.) protected length range (PLR or 'slot limit') regulation. Slot limits promote growth of smaller fish by reducing competition through angler harvest (Anderson 1976), which may be more easily accomplished in tailwater fisheries maintained by stocking (e.g., Norris), where 'year class strength' can be controlled. Slot limits have been shown to improve size structures of sport fish populations including Largemouth Bass *Micropterus salmoides* (Wilde 1997) and trout (Luecke et al. 1994; Power and Power 1996). Accordingly, the Norris tailwater PLR regulation has successfully improved (and maintained) trout population size structure, and anglers have recognized this by overwhelmingly expressing their support for the PLR (2013 creel survey; Habera et al. 2014b). The current Norris

Norris Dam.

tailwater management plan term ends in 2019. Existing information, along with electrofishing and creel survey data collected in 2019, will be used to revise and update the management plan for 2020-2025.

Norris Tailwater

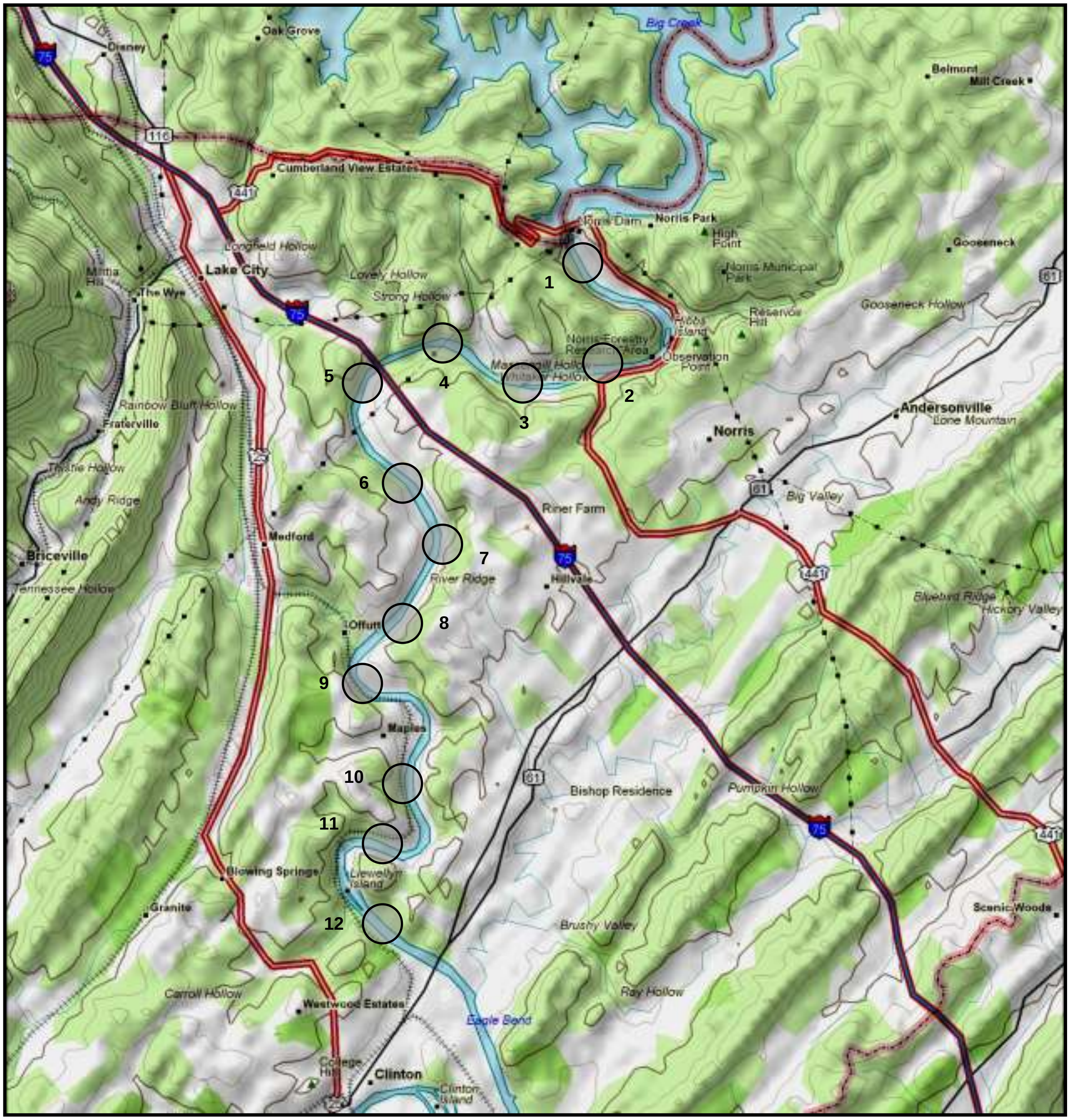


Figure 3-1. Locations of the Norris tailwater (Clinch River) monitoring stations.

Table 3-1. Location and sampling information for the 12 stations on the Norris tailwater, 22 March 2018.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420180501	Anderson	Norris 137 NE	36.22222N-84.09250W	06010207-19,1	79.7	600	150 V DC 120 PPS, 4 A
2	420180502	Anderson	Norris 137 NE	36.20466N-84.08651W	06010207-19,1	77.2	600	530 V DC 120 PPS, 5 A
3	420180503	Anderson	Norris 137 NE	36.20370N-84.10006W	06010207-19,1	76.3	600	530 V DC 120 PPS, 5 A
4	420180504	Anderson	Norris 137 NE	36.20654N-84.12265W	06010207-19,1	75.6	600	530 V DC 120 PPS, 5 A
5	420180505	Anderson	Lake City 137 NW	36.20433N-84.12580W	06010207-19,0	74.4	600	530 V DC 120 PPS, 5 A
6	420180506	Anderson	Lake City 137 NW	36.19722N-84.12778W	06010207-19,0	74.1	600	150 V DC 120 PPS, 4 A
7	420180507	Anderson	Norris 137 NE	36.18611N-84.11667W	06010207-19,0	73	600	150 V DC 120 PPS, 5 A
8	420180508	Anderson	Norris 137 NE	36.17500N-84.11806W	06010207-19,0	72.2	600	150 V DC 120 PPS, 4 A
9	420180509	Anderson	Norris 137 NE	36.16028N-84.12028W	06010207-19,0	70.4	600	150 V DC 120 PPS, 4 A
10	420180510	Anderson	Norris 137 NE	36.14681N-84.11853W	06010207-19,0	69.5	600	530 V DC 120 PPS, 5 A
11	420180511	Anderson	Norris 137 NE	36.14306N-84.11750W	06010207-19,0	69.1	600	150 V DC 120 PPS, 4 A
12	420180512	Anderson	Lake City 137 NW	36.13151N-84.12628W	06010207-19,0	67.2	488	530 V DC 120 PPS, 5 A

Table 3-2. Catch data for the12 electrofishing stations on the Norris tailwater sampled 22 March 2018.

Station	Species	Total catch	Size range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	9	21-355	2,868	24	14
	Brown	28	259-521	17,686	74	85
	Brook	1	286	189	3	1
Totals		**38**		**20,743**	**100**	**100**
2	Rainbow	50	153-504	16,128	81	88
	Brown	5	254-326	1,051	8	6
	Brook	7	216-285	1,069	11	6
Totals		**62**		**18,248**	**100**	**100**
3	Rainbow	58	181-460	18,166	73	78
	Brown	15	180-500	3,917	19	17
	Brook	7	251-284	1,186	9	5
Totals		**80**		**23,269**	**100**	**100**
4	Rainbow	11	222-451	3,508	100	100
Totals		**11**		**3,508**	**100**	**100**
5	Rainbow	48	175-472	15,104	96	97
	Brown	1	309	331	2	2
	Brook	1	265	184	2	1
Totals		**50**		**15,619**	**100**	**100**
6	Rainbow	21	203-413	5,781	95	95
	Brown	1	320	309	5	5
Totals		**22**		**6,090**	**100**	**100**
7	Rainbow	39	190-468	11,718	87	51
	Brown	6	302-712	11,278	13	49
Totals		**45**		**22,996**	**100**	**100**
8	Rainbow	34	178-416	6,723	92	83
	Brown	2	313-477	1,250	5	15
	Brook	1	268	157	3	2
Totals		**37**		**8,130**	**100**	**100**
9	Rainbow	62	174-480	17,633	97	80
	Brown	2	336-722	4,318	3	20
Totals		**64**		**21,951**	**100**	**100**
10	Rainbow	34	185-490	8,633	94	80
	Brown	2	427-545	2,190	6	20
Totals		**36**		**10,823**	**100**	**100**
11	Rainbow	36	192-507	8,021	97	87
	Brown	1	505	1,183	3	11
Totals		**37**		**9,204**	**100**	**87**
12	Rainbow	27	192-489	7,203	90	80
	Brown	2	420-460	1,651	7	18
	Brook	1	293	204	3	2
Totals		**30**		**9,058**	**100**	**100**
Total Rainbow Trout		429	153-507	121,486	84	72
Total Brown Trout		65	180-722	45,164	13	27
Total Brook Trout		18	216-293	2,989	4	2
Overall		**512**		**169,639**	**100**	**100**

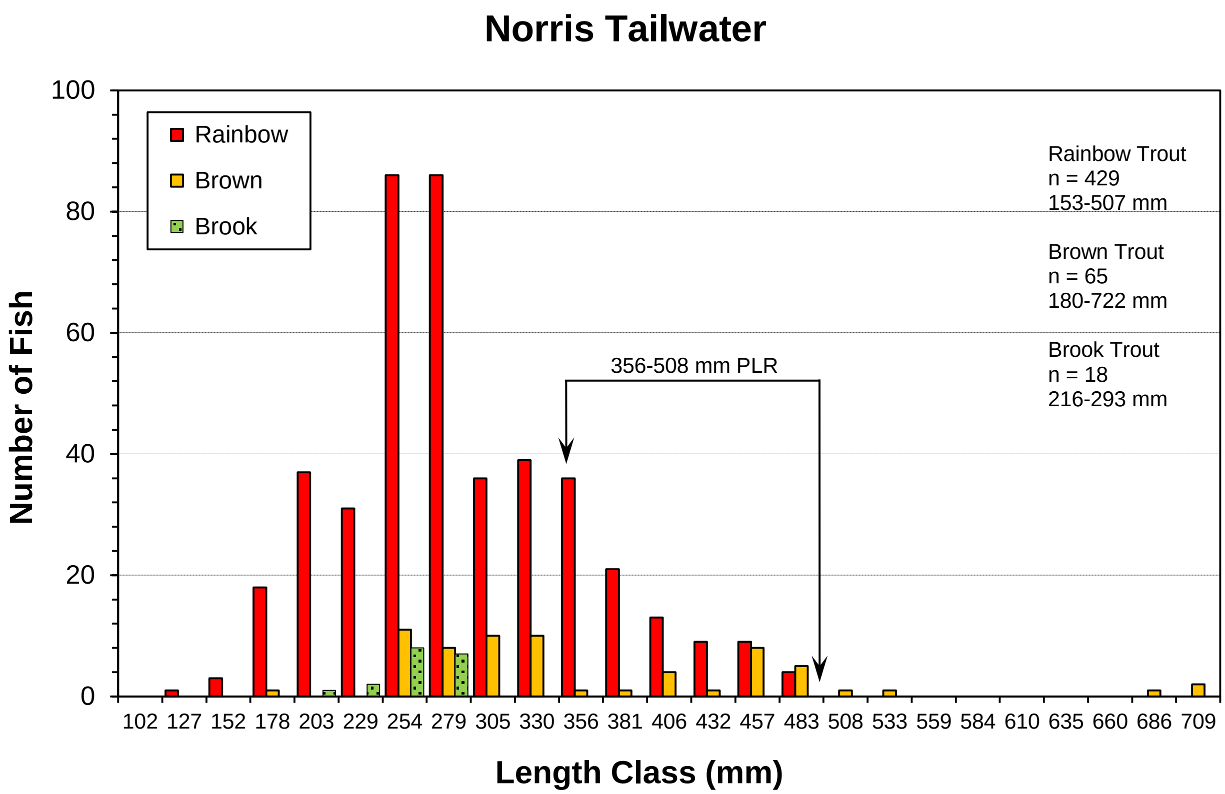
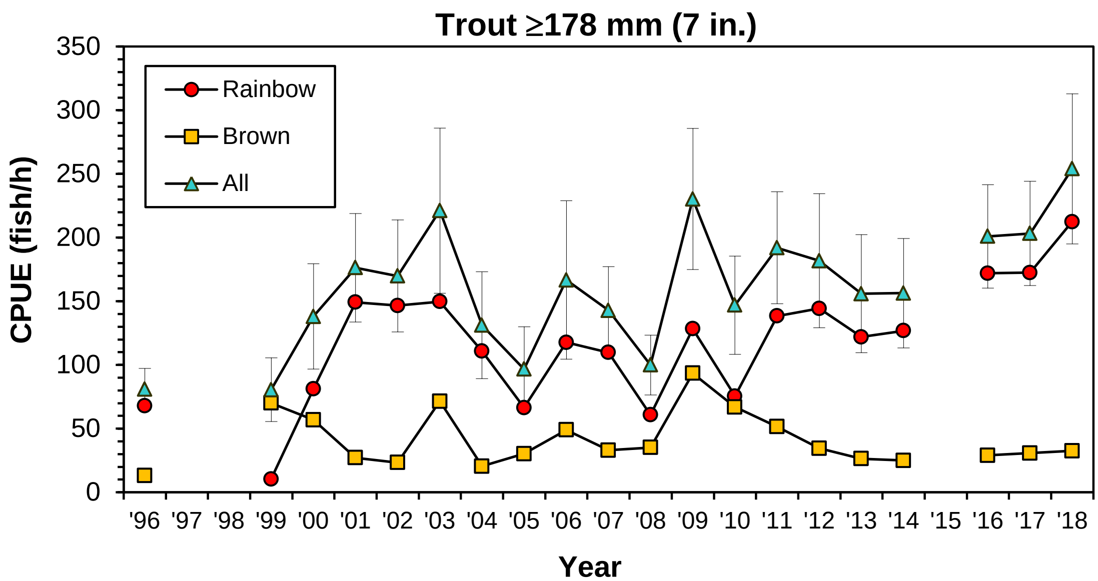


Figure 3-2. Length frequency distributions for trout from the Norris tailwater monitoring stations in 2018.

Norris Tailwater



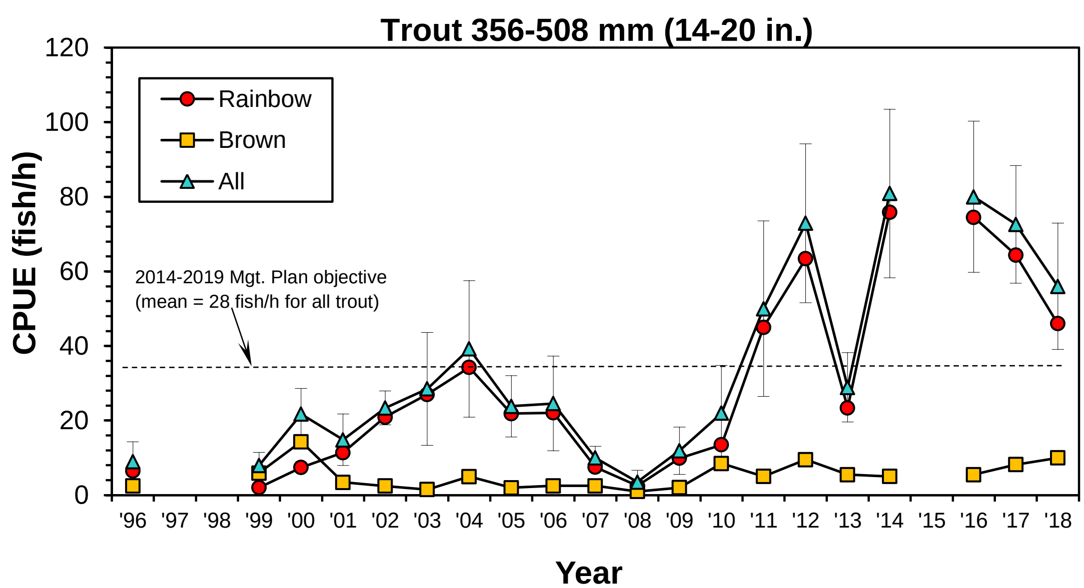


Figure 3-3. Mean trout CPUEs for the Norris tailwater samples. Bars indicate 90% confidence intervals. The 356-508 mm PLR regulation was established in 2008.

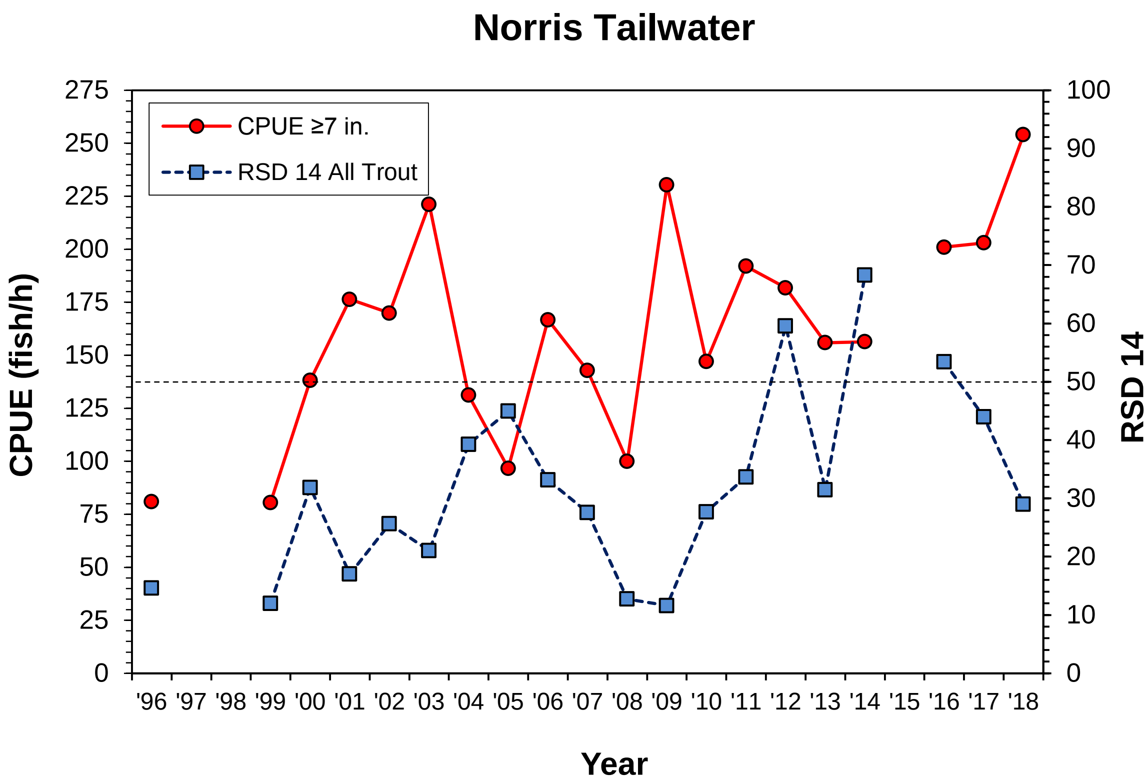


Figure 3-4. RSD-14 Norris tailwater trout compared with corresponding CPUE for fish ≥178 mm. Dashed line indicates an RSD-14 of 50 (50% of all stock-size trout—those ≥254 mm or 10 in.—are ≥356 mm or 14 in.).

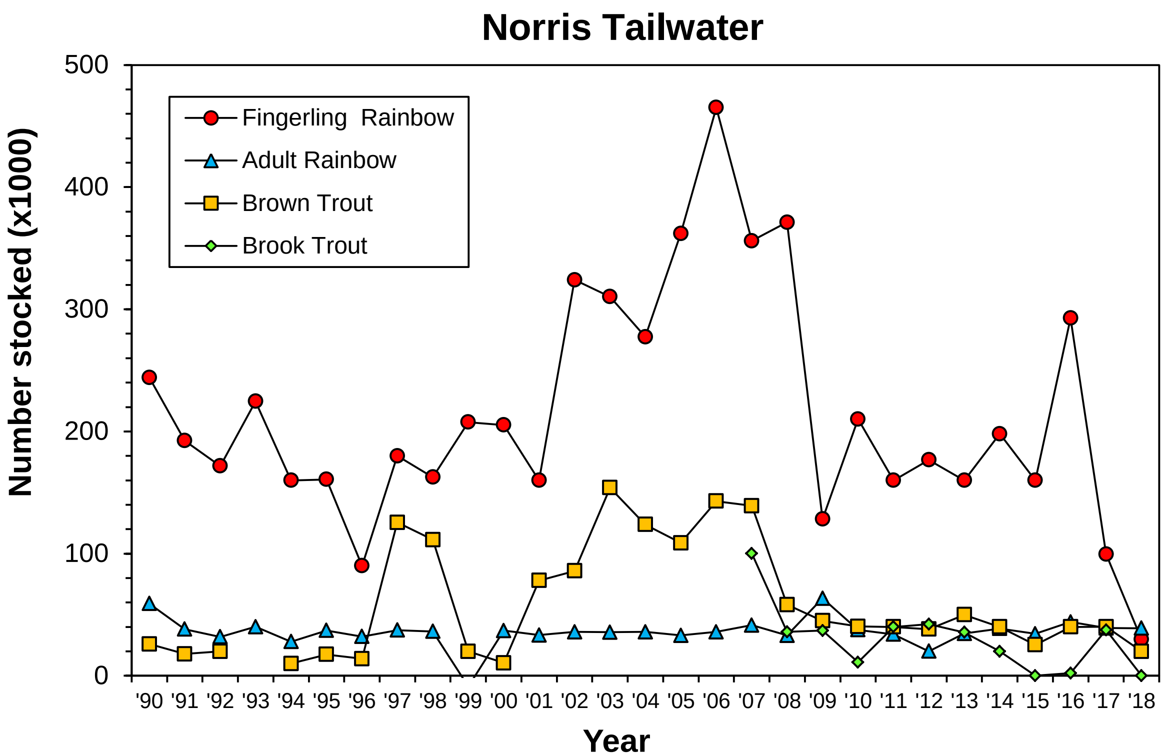


Figure 3-5. Recent trout stocking rates for the Norris tailwater. Current management plan stocking allocations are 160,000 fingerling Rainbow Trout, 37,000 adult Rainbow Trout, 20,000-40,000 Brown Trout, and 20,000 Brook Trout annually (~237,000 trout/year). Stocking rates were adjusted for fingerling Rainbow Trout in 2017 and 2018 and for Brook Trout in 2018 to compensate for Dale Hollow National Fish Hatchery's need to stock some fish early because of deteriorating water quality conditions in November 2016 and 2017.

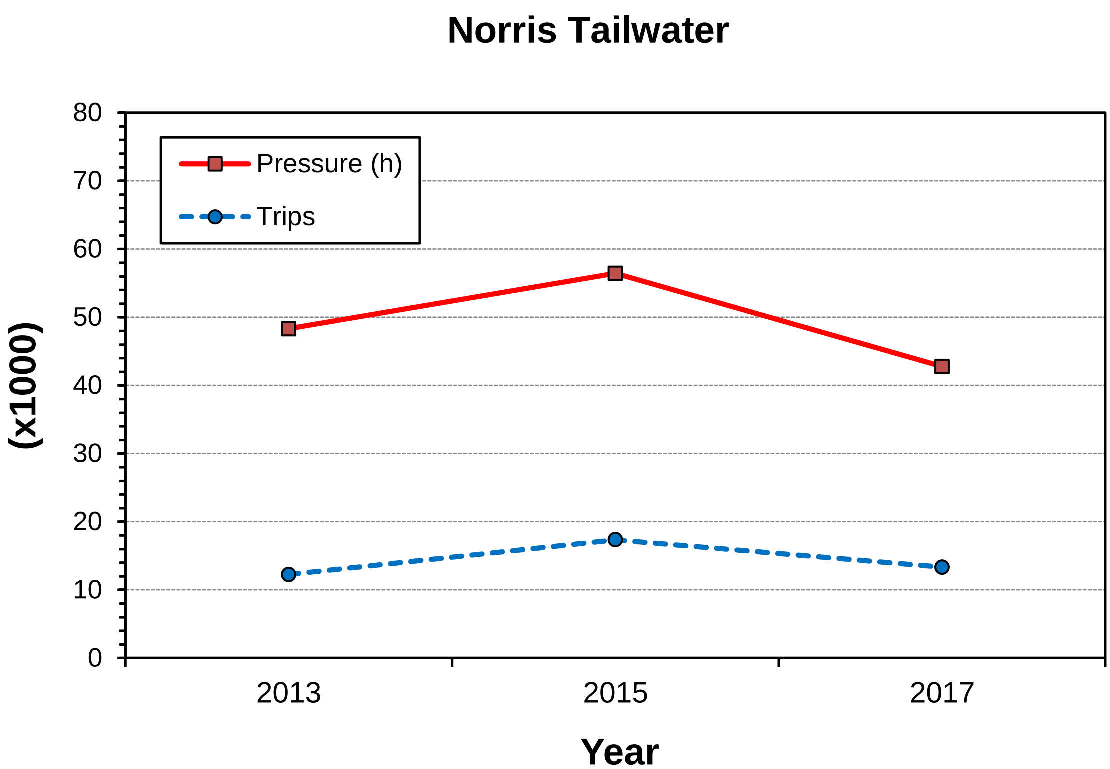


Figure 3-6. Creel survey results (angling pressure and trips) for the Norris tailwater during 2013-2017.

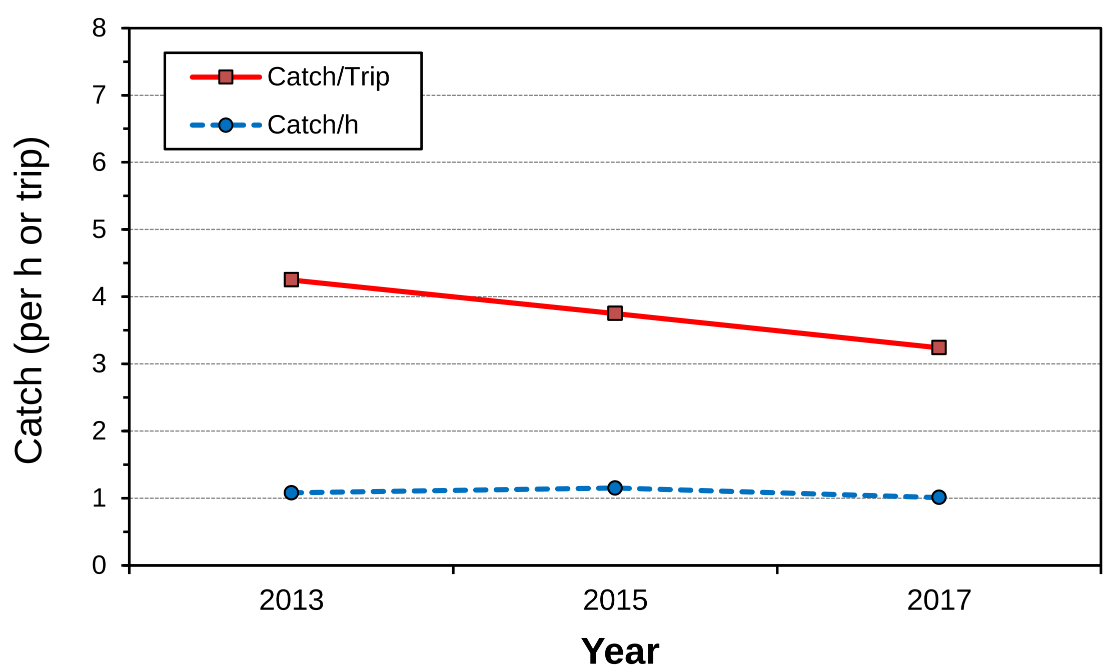


Figure 3-7. Creel survey results (catch/h and catch/trip) for the Norris tailwater during 2013-2017.

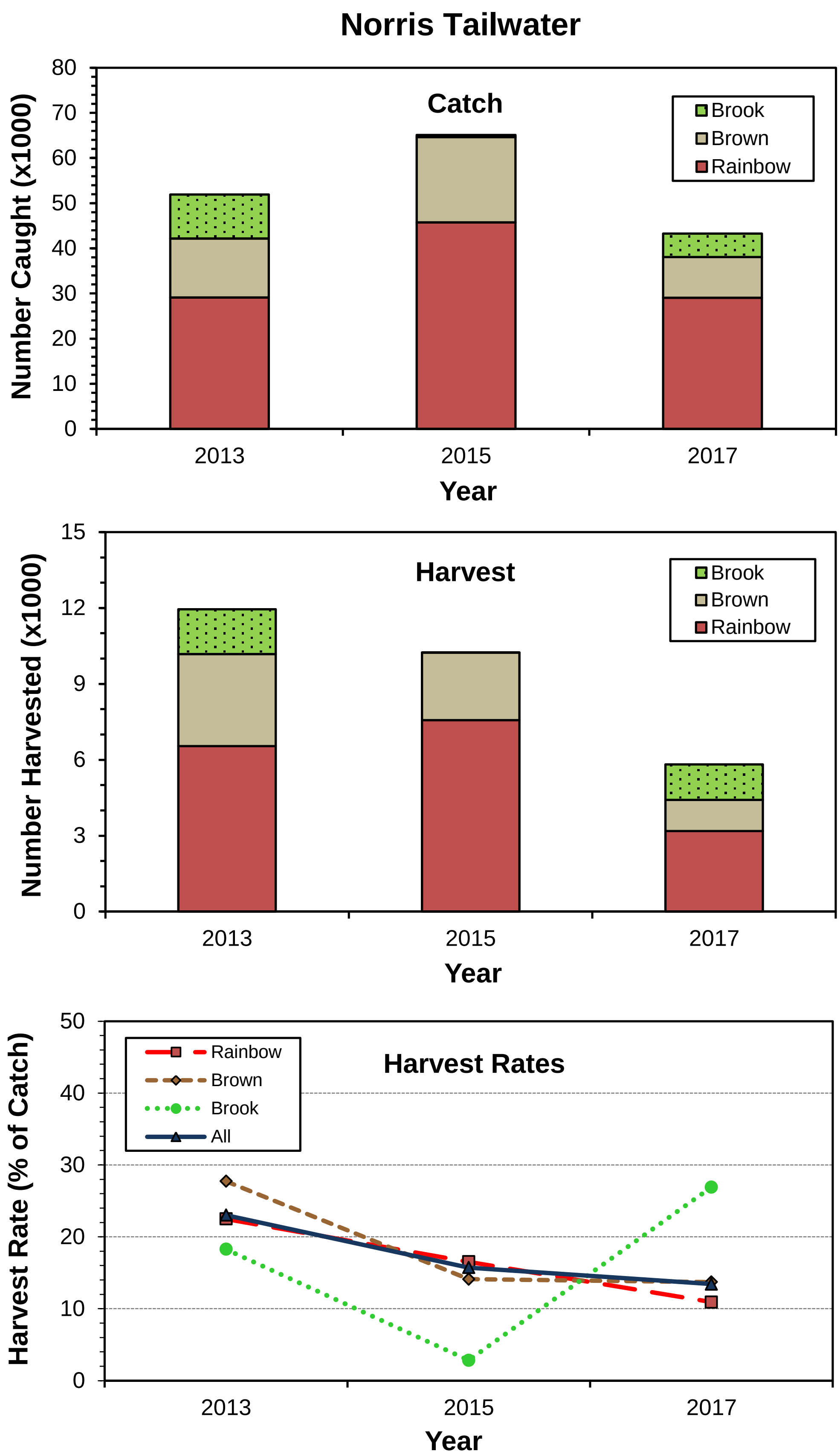


Figure 3-8. Creel survey results (catch and harvest) for the Norris tailwater during 2013-2017.

3.2.2 Cherokee (Holston River)

Study Area

Cherokee Dam impounds 12,272-ha (30,300-acre) Cherokee Reservoir on the Holston River near Jefferson City. The dam is located about 83 km (52 mi.) upstream of the confluence of the Holston and French Broad rivers in Knoxville and the reservoir has an 8,879-km^2 (3,428-mi.^{2}) watershed. Historically, low dissolved oxygen (DO) levels (Higgins 1978) and the lack of a minimum flow in the Cherokee tailwater impacted its aquatic communities. TVA established a minimum flow of 9.2 m^3/s (325 cfs) in 1988 as part of its release improvements program, then began to address low DO levels in 1995 (Scott et al. 1996). Dissolved oxygen levels in the tailwater were improved by installation of a liquid oxygen injection system in the forebay area of the reservoir and through turbine venting aided with hub baffles (Scott et al. 1996). These improvements have helped TVA meet the DO target of 4.0 mg/L in the tailwater and as a result, fish and macroinvertebrate communities have substantially improved.


Cherokee tailwater.

Seasonal temperature regimes, in addition to water quality and quantity problems, were an impediment to fisheries management in the Cherokee tailwater for many years (Hill and Brown 1980). Pfitzer (1962) characterized temperatures as being too cold for warmwater fishes in the spring and too warm for trout in the summer. However, it was generally regarded as supporting a warmwater fish community (Scott et al. 1996; Hill and Brown 1980). TWRA stocked trout infrequently, releasing 39,000 Rainbow Trout, Brown Trout, and Brook Trout (fingerlings and adults) during 1951-1955, and 16,000 Brown Trout in 1974. These efforts likely had limited success as they took place prior to TVA’s water quality improvements. Trout stocking became more consistent after 1995 and stocking rates were increased as water quality improved.

The upper 30 km (18.8 mi.) of the Cherokee tailwater, from the dam downstream to the vicinity of Nance Ferry, is now being managed primarily as a put-and-take trout fishery, although some Rainbow Trout and Brown Trout survive beyond a year, providing a put-and-grow aspect as well. The Cherokee tailwater has become popular among area anglers and has drawn some pressure away from other Region IV tailwaters (particularly the Clinch River). Because of the warmer water and abundant food supply (particularly caddis flies), trout grow extremely well, providing the potential for a quality fishery. However, late summer temperatures can exceed and remain above 21° C (70° F) for weeks, creating a thermal ‘bottleneck’ that severely limits trout survival (i.e., carryover). The abundance of warmwater species (e.g., Buffalo *Ictiobus* sp., Gizzard Shad *Dorosoma cepedianum*, and Channel Catfish *Ictalurus punctatus)*—along with the relative scarcity of trout in October electrofishing surveys—indicates that the Cherokee tailwater provides marginal trout habitat during summer and early fall.

The 12 electrofishing monitoring stations on the Cherokee tailwater (Figure 3-9) were sampled in June and October 2018. The June sample was conducted to document abundance prior to the annual thermal bottleneck and to provide a baseline for comparison with the previous (October 2017) and subsequent (October 2018) samples. Sample site locations and effort details are summarized in Table 3-3. Temperature data were also collected (measured hourly by Onset TidbiT® *v2* loggers) near Cherokee Dam and at Blue Spring during June-November 2018.

Results and Discussion

The 12 Cherokee tailwater electrofishing stations produced 36 trout (31 Rainbow Trout, 5 Brown Trout) weighing over 24 kg on 20 June 2018 (Table 3-4). Although water temperature on that date ranged from 14.1-15.8° C, no trout were captured at four stations (1, 4, 7, and 11; Table 3-4). The mean catch rate for all trout ≥178 mm (18.0 fish/h, Figure 3-10) exceeded all previous fall samples (maximum, 16.0 fish/h in 2012; Figure 3-11), but not by as much as anticipated. The mean catch rate for trout ≥356 mm in the June 2018 sample (7.5 fish/h; Figure 3-10) was within the range for fall samples (0.5-9.5 fish/h; Figure 3-11), but the catch rate for trout ≥457 mm (3.5 fish/h; Figure 3-10) exceeded the highest value for any fall sample (2.5 fish/h; Figure 3-11). The effect of angler harvest on these large fish during June-October is unknown, but they may also be particularly susceptible to the annual thermal bottleneck.

An 18.6 in., 3.1 lb. Rainbow Trout from the June 2018 Cherokee tailwater sample.

The subsequent 31 October 2018 Cherokee tailwater sample produced 19 trout (16 Rainbow Trout, 3 Brown Trout) weighing 11 kg (Table 3-5). The mean catch rate for trout ≥178 mm (9.5 fish/h; Figure 3-10) decreased nearly 50% relative to the June sample and was similar to that for the October 2017 sample (11.0 fish/h; Figure 3-10). Mean catch rates for larger trout in October 2018 (6.0 fish/h ≥356 mm and 2.0 fish/h ≥457; Figure 3-10) mm also decreased somewhat relative to the June sample.

Most Rainbow Trout (61%) collected during the June 2018 Cherokee tailwater sample were in the 279-356 mm (11-14 in.) size classes, with some fish reaching into the 508 mm (20 in.) size range (Figure 3-12). Brown Trout in the 229-584 mm (9-23 in.) size classes were captured, but no particular size range predominated (Figure 3-12). By October 2018, the modal size class for Rainbow Trout has shifted from 305 mm to 356 mm, indicating an average growth of about 51 mm (2 in.) during the previous four months. Given the presence of fish >457 mm (18 in.) in both 2018 samples (Figure 3-12) and most previous years (Habera et al. 2018a), it is evident that some trout of both species survive the September/October thermal bottleneck at least once.

Water temperatures near Cherokee Dam in 2018 were cooler than in 2017 (an exceptionally warm year; Habera et al. 2018a). Maximum daily water temperature reached 21° C on 30 August—23 days later than in 2017—then remained above 21° C during 6 September through 26 October (51 consecutive days; Figure 3-13). On average, (2005-2018), mean maximum temperature at this site reaches 21° C on 27 August and remains above 21° C for 57 days (through 22 October; Figure 3-13). Maximum daily temperature reached 24° C only three times in 2017, but it did so 26 times in 2018 (September and October) and exceeded 25° C during 14-17 September (Figure 3-13). Minimum daily water temperature reached 21° C on 11 September and exceeded 21° C for 43 of the next 45 days (Figure 3-13), thus there was no coldwater habitat during that period. Minimum daily temperature exceeded 21° C an average of 15 days each year during 2005-2014, but that average has increased to 49 days each year since then. Overall, daily mean minimum water temperature for the 14-year period reached 21° C during the 26-day period from 13 September through 8 October—during which there is no coldwater habitat (Figure 3-13).

Maximum daily water temperature at the Blue Spring site (13 km below Cherokee Dam) reached 21° C on 4 August—over six weeks later than in 2017 (17 June). It then exceeded 21° C for 71 of the next 84 days (through 26 October; Figure 3-14). Maximum daily temperatures above 24° C (29 days) and 25° C (11 days) were relatively common in 2018. On average, (2003-2018), maximum daily temperature at this site reaches 21° C on 16 August and remains above 21° C for 68 days (through 22 October; Figure 3-14). Minimum daily water temperature reached 21° C on 11 September —24 days later than in 2017—and remained above 21° C for 42 of the next 45 consecutive days (through October 25; Figure 3-14), thus there was essentially no coldwater habitat during that period. However, minimum daily temperatures reached higher levels in 2018 (>23° C on 32 days; >24° C 13 on days) than in 2017 (minimum daily temperature did not reach 23° C). On average (2003-2018), the Blue Spring area typically has no coldwater habitat (daily minimum water temperature is >21° C) during September and the first nine days of October (Figure 3-14). Water temperatures in the Cherokee tailwater typically return to trout-tolerant levels (<21° C) by mid- to late October (27 October in 2018; Figures 3-13 and 3-14).

The Cherokee tailwater received 55,000 adult (mean length, 239 mm) Rainbow Trout and 46,000 sub-adult (mean length, 199 mm) Brown Trout in 2018 (Figure 3-15). Stocking rates during the past five years have been lower—averaging 29,000 adult Rainbow Trout and sub-adult 29,000 Brown Trout annually. There is little correlation between adult/sub-adult Rainbow Trout and Brown

Trout stocking rates during October-May (35,000-109,000) and subsequent fall electrofishing catch rates (Figure 3-16). However, fall electrofishing catch rates do appear to be generally correlated with summer/early fall water temperatures, which in turn are related to variability in flow from Cherokee Dam during June-October. Above average precipitation in some years (e.g., 2003, 2013, and 2017) results in higher average flows from Cherokee Dam, earlier depletion of cold water stored in the reservoir, and unsuitably warm tailwater temperatures for long periods of time. The reverse is true during dry years such as 2007 and 2008. Consequently, there is a relatively strong (R^2 = 0.51) inverse relationship (2nd order polynomial) between the number of days where minimum water temperature was ≥22° C at the Blue Spring site and the electrofishing catch rate (log_{10}-transformed +1; Figure 3-17). In turn, there is also a relatively strong (R^2 = 0.52) positive relationship (2nd order polynomial) between higher water temperatures (expressed as the number of days where the minimum was ≥21° C at Blue Spring) and higher mean flow for March – August (Figure 3-18). There may also be a relationship (e.g., in 2016) where extended periods of low flows and high air temperatures in late summer combine to raise water temperatures to levels that impact trout survival.

Management Recommendations

Trout in the Cherokee tailwater are subject to, on average, about a month (typically September) each year without coldwater habitat—minimum temperatures exceed 21° C and maximums often reach 24-25° C. Consequently, most trout survive less than a year, even with a relatively low harvest rate (Habera et al. 2015a). However, some fish that are able to find thermal refugia such as groundwater upwellings or cooler tributaries (Baird and Krueger 2003) can survive through at least one thermal bottleneck—evident by the large (≥457 mm) fish that have been are captured in most fall samples and in the June 2018 sample (Figure 3-12). Current policy excludes stocking fingerling Rainbow Trout because of their low recruitment potential and avoids stocking any fish during July-October because of high water temperatures (>21° C) during those months.

A 23.4 in., 4.8 lb. Brown Trout from the June 2018 Cherokee tailwater sample.

Despite limited trout carry-over caused by annual thermal bottlenecks, the Cherokee tailwater is well worth managing as a trout fishery, as trout angling opportunities are available during most months. The thermal regime and benthic community of the Cherokee tailwater make it more like a natural trout stream than other Tennessee tailwaters. The abundance of trichopterans (particularly *Cheumatopsyche* spp.; Habera et al. 2004) undoubtedly enhances trout growth and prolific mayfly and caddis hatches during the spring provide excellent flyfishing opportunities. Cherokee tailwater trout anglers caught an estimated 0.63 fish/h and 2.89 fish/trip (88% Rainbow Trout) in 2014 (the most recent survey), while harvesting 0.27 fish/h and 1.21 fish/trip (Black 2015).

Current angling regulations (i.e., general statewide for trout) are appropriate for maintaining this fishery. A majority of Cherokee tailwater anglers (72%) rated TWRA's management of this fishery as good or excellent during the 2014 survey (Habera et al. 2015a). Anglers occasionally request special regulations (minimum size or slot limits), but they would be of little value as few fish protected by such measures would survive the summer thermal bottleneck. Annual fall sampling at the 12 existing monitoring stations should continue, along with at least two more supplemental summer (June) surveys to further develop the trout fishery database and evaluate Annual water temperature monitoring (summer and fall) should also be continued to help further understand the relationship among temperature, flow, and trout abundance. These basic recommendations, along with determining optimal annual stocking rates and evaluating survival and growth of various stocked cohorts, will be incorporated into a management plan for this tailwater (to be developed during 2019) to ensure its potential as a trout fishery is maximized.

Cherokee Tailwater

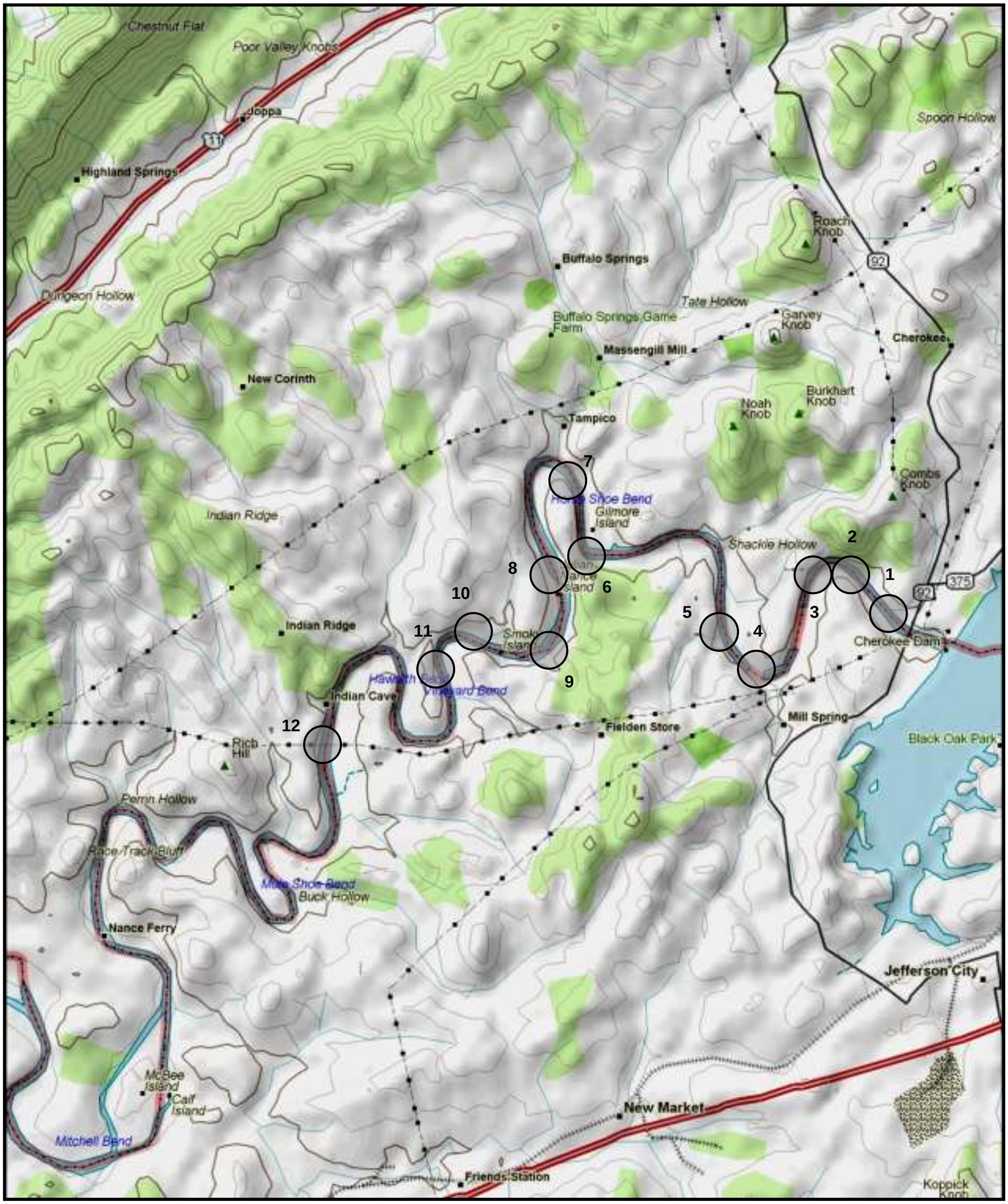


Figure 3-9. Locations of the Cherokee tailwater (Holston River) monitoring stations.

Table 3-3 Location and sampling information for the 12 stations on the Cherokee tailwater, 20 June and 31 October 2018.

Station	Site Code[1]	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420181601	Grainger/ Jefferson	Joppa 155 NE	36.16864N-83.50461W	06010104-3,4	51.8	600	530 V DC 120 PPS, 5-6 A
2	420181602	Grainger	Joppa 155 NE	36.17589N-83.51183W	06010104-3,4	51.2	600	175 V DC 120 PPS, 4-6 A
3	420181603	Grainger	Joppa 155 NE	36.17858N-83.51667W	06010104-3,4	50.9	600	530 V DC 120 PPS, 5-6 A
4	420181604	Grainger/ Jefferson	Joppa 155 NE	36.16244N-83.52933W	06010104-3,4	49.5	600	175 V DC 120 PPS, 4-6 A
5	420181605	Jefferson	Joppa 155 NE	36.16767N-83.53564W	06010104-3,4	49.0	600	530 V DC 120 PPS, 5-6 A
6	420181606	Grainger/ Jefferson	Joppa 155 NE	36.17978N-83.55542W	06010104-3,4	47.0	600	175 V DC 120 PPS, 4-6 A
7	420181607	Jefferson	Joppa 155 NE	36.18825N-83.56036W	06010104-3,4	46.2	600	530 V DC 120 PPS, 5-6 A
8	420181608	Jefferson	Joppa 155 NE	36.17658N-83.56161W	06010104-3,4	44.7	600	175 V DC 120 PPS, 4-6 A
9	420181609	Jefferson	Joppa 155 NE	36.16733N-83.56281W	06010104-3,4	44.0	600	530 V DC 120 PPS, 5-6 A
10	420181610	Grainger/ Jefferson	Joppa 155 NE	36.16633N-83.57314W	06010104-3,4	43.5	600	175 V DC 120 PPS, 4-6 A
11	420181611	Grainger	Joppa 155 NE	36.16458N-83.58286W	06010104-3,4	42.7	600	530 V DC 120 PPS, 5-6 A
12	420181612	Grainger	Joppa 155 NE	36.15339N-83.60217W	06010104-3,4	39.5	600	175 V DC 120 PPS, 4-6 A

[1]Site codes are for the June 20, 2018 sample; site codes for the October sample are 420182901-420182912 (other sampling information is the same).

Table 3-4. Catch data for the 12 electrofishing stations on the Cherokee tailwater sampled 20 June 2018.

Station	Species	Total Catch	Size Range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
2	Rainbow	4	330-495	3,341	100	100
	Brown	0	--	0	0	0
Totals		**4**		**3,341**	**100**	**100**
3	Rainbow	1	475	1288	100	100
	Brown	0	--	0	0	0
Totals		**1**		**1,288**	**100**	**100**
4	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
5	Rainbow	3	226-526	3,011	60	59
	Brown	2	394-445	2,070	40	41
Totals		**5**		**5,081**	**100**	**100**
6	Rainbow	3	305-340	1,245	100	100
	Brown	0	--	0	0	0
Totals		**3**		**1,245**	**100**	**100**
7	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
8	Rainbow	2	324-343	907	67	29
	Brown	1	595	2,178	33	71
Totals		**3**		**3,085**	**100**	**100**
9	Rainbow	13	255-396	5,744	93	97
	Brown	1	252	206	7	3
Totals		**14**		**5,950**	**100**	**100**
10	Rainbow	2	308-472	1,703	67	94
	Brown	1	230	116	33	6
Totals		**3**		**1,819**	**100**	**100**
11	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
12	Rainbow	3	300-470	2,819	100	100
	Brown	0	--	0	0	0
Totals		**3**		**2,819**	**100**	**100**
Total Rainbows		31	226-526	20,058	86	81
Total Browns		5	230-595	4,570	14	19
Overall		**36**		**24,628**	**100**	**100**

Table 3-5. Catch data for the 12 electrofishing stations on the Cherokee tailwater sampled 31 October 2018.

Station	Species	Total Catch	Size Range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
2	Rainbow	1	368	431	100	100
	Brown	0	--	0	0	0
Totals		**1**		**431**	**100**	**100**
3	Rainbow	1	299	245	50	52
	Brown	1	286	224	50	48
Totals		**2**		**469**	**100**	**100**
4	Rainbow	4	313-489	2685	100	100
	Brown	0	--	0	0	0
Totals		**4**		**2,685**	**100**	**100**
5	Rainbow	4	314-490	2,434	67	80
	Brown	2	286-313	602	33	20
Totals		**6**		**3,036**	**100**	**100**
6	Rainbow	1	334	434	100	100
	Brown	0	--	0	0	0
Totals		**1**		**434**	**100**	**100**
7	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
8	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
9	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
10	Rainbow	1	497	1,082	100	100
	Brown	0	--	0	0	0
Totals		**1**		**1,082**	**100**	**100**
11	Rainbow	2	372-411	1,187	100	100
	Brown	0	--	0	0	0
Totals		**2**		**1,187**	**100**	**100**
12	Rainbow	2	365-502	1,651	100	100
	Brown	0	--	0	0	0
Totals		**2**		**1,651**	**100**	**100**
Total Rainbows		16	299-502	10,149	84	92
Total Browns		3	286-313	826	16	8
Overall		**19**		**10,975**	**100**	**100**

Cherokee Tailwater

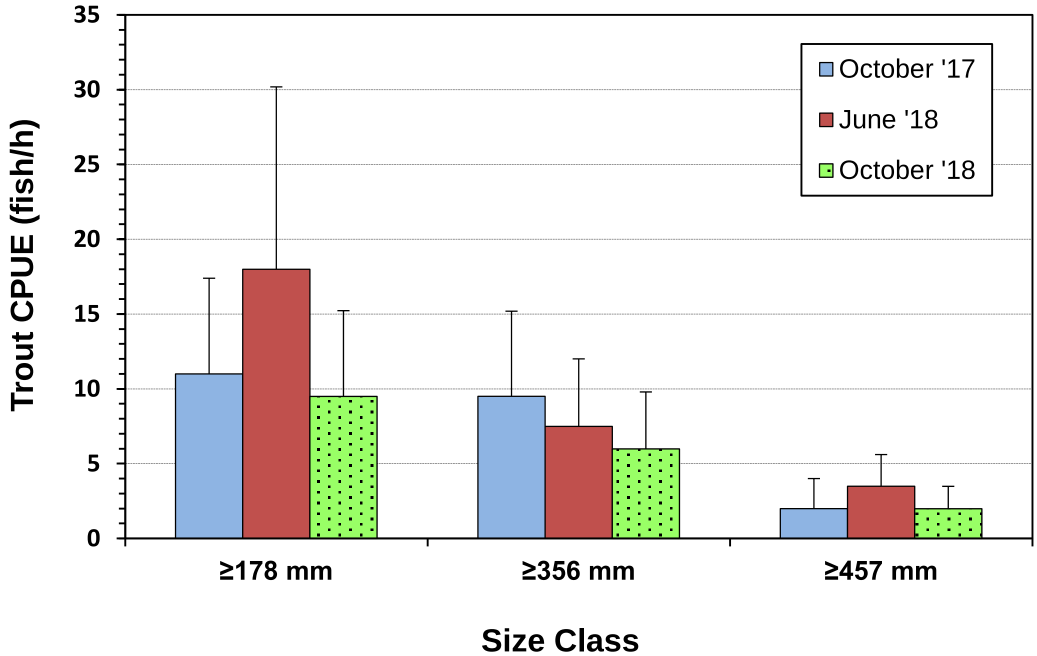


Figure 3-10. Mean CPUEs (by trout size class) for the previous three Cherokee tailwater samples (October 2017-October 2018). Bars indicate 90% confidence intervals.

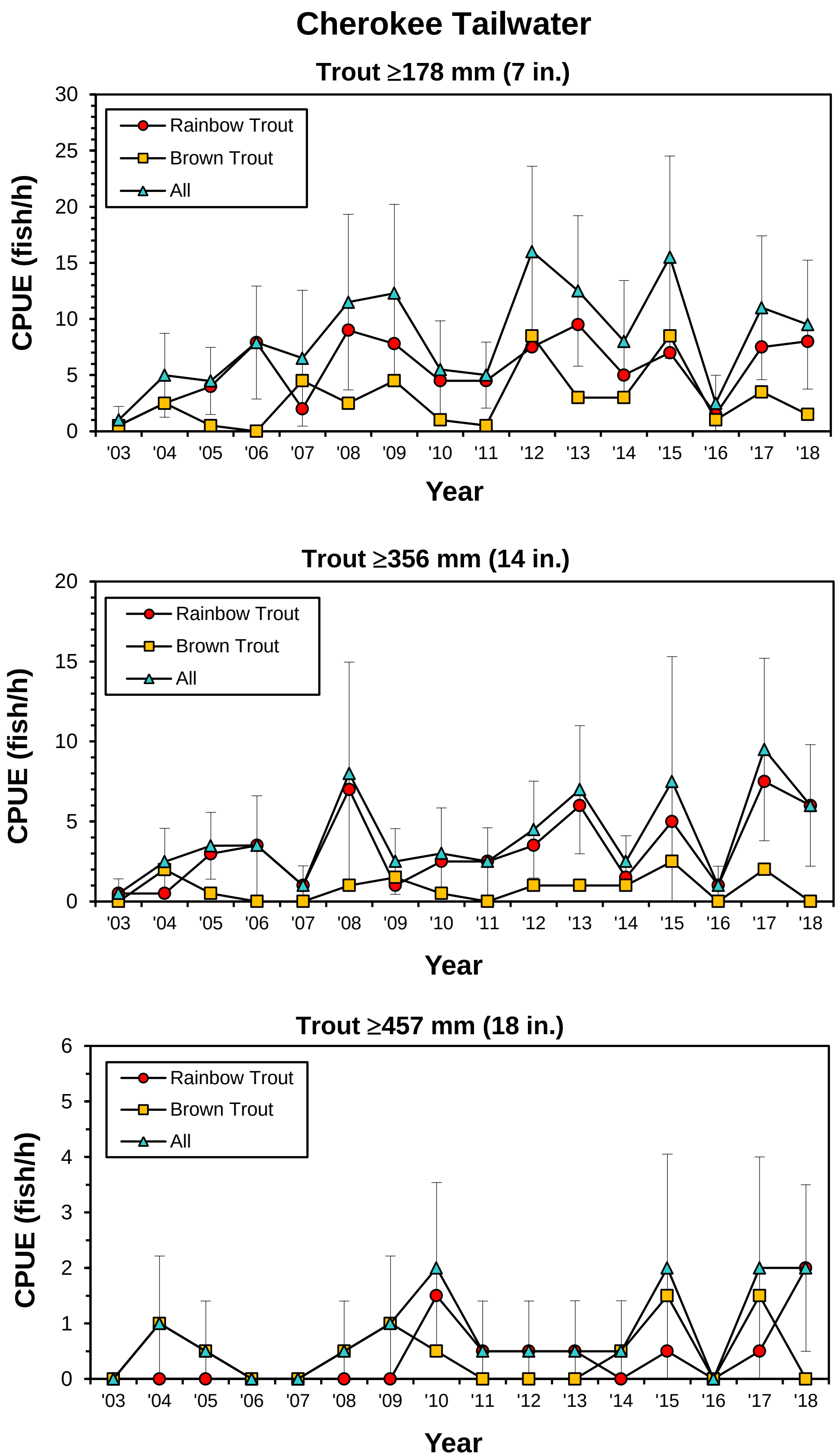
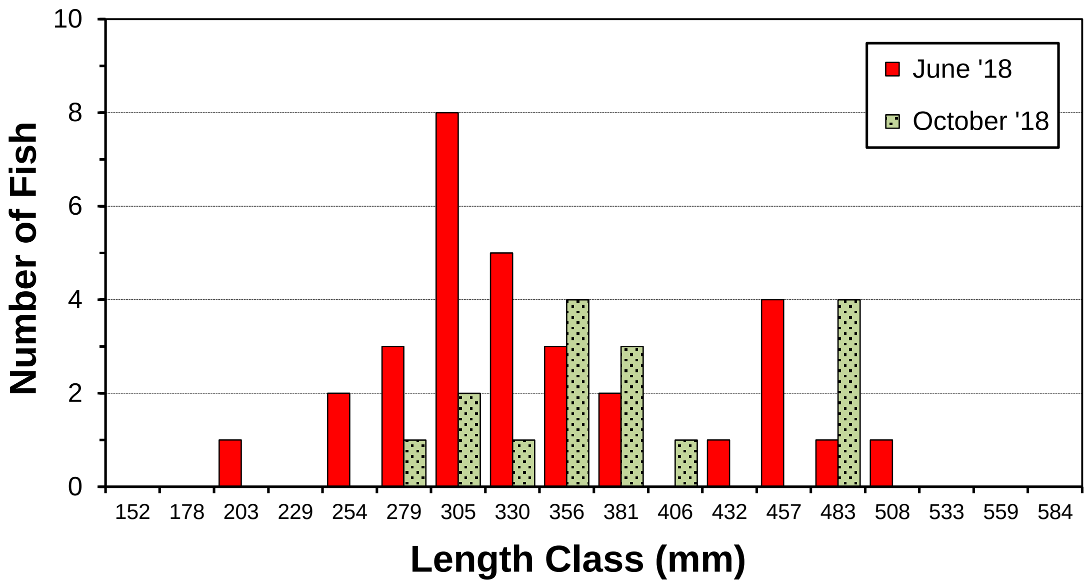


Figure 3-11. Mean trout CPUEs for the annual October Cherokee tailwater samples. Bars indicate 90% confidence intervals.

Cherokee Tailwater



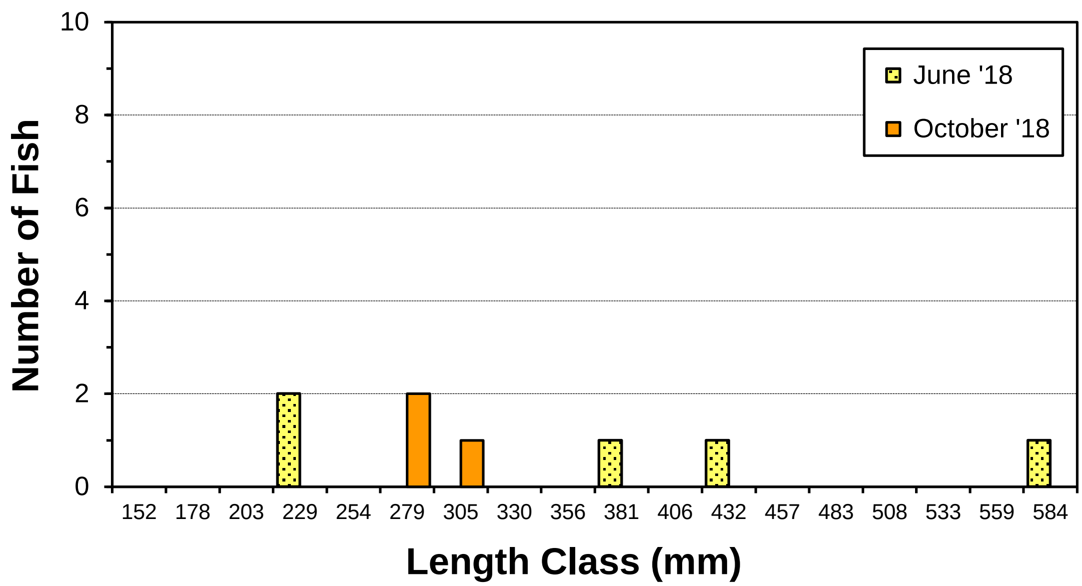


Figure 3-12. Length frequency distributions for trout from the Cherokee tailwater monitoring stations during the June and October 2018 samples.

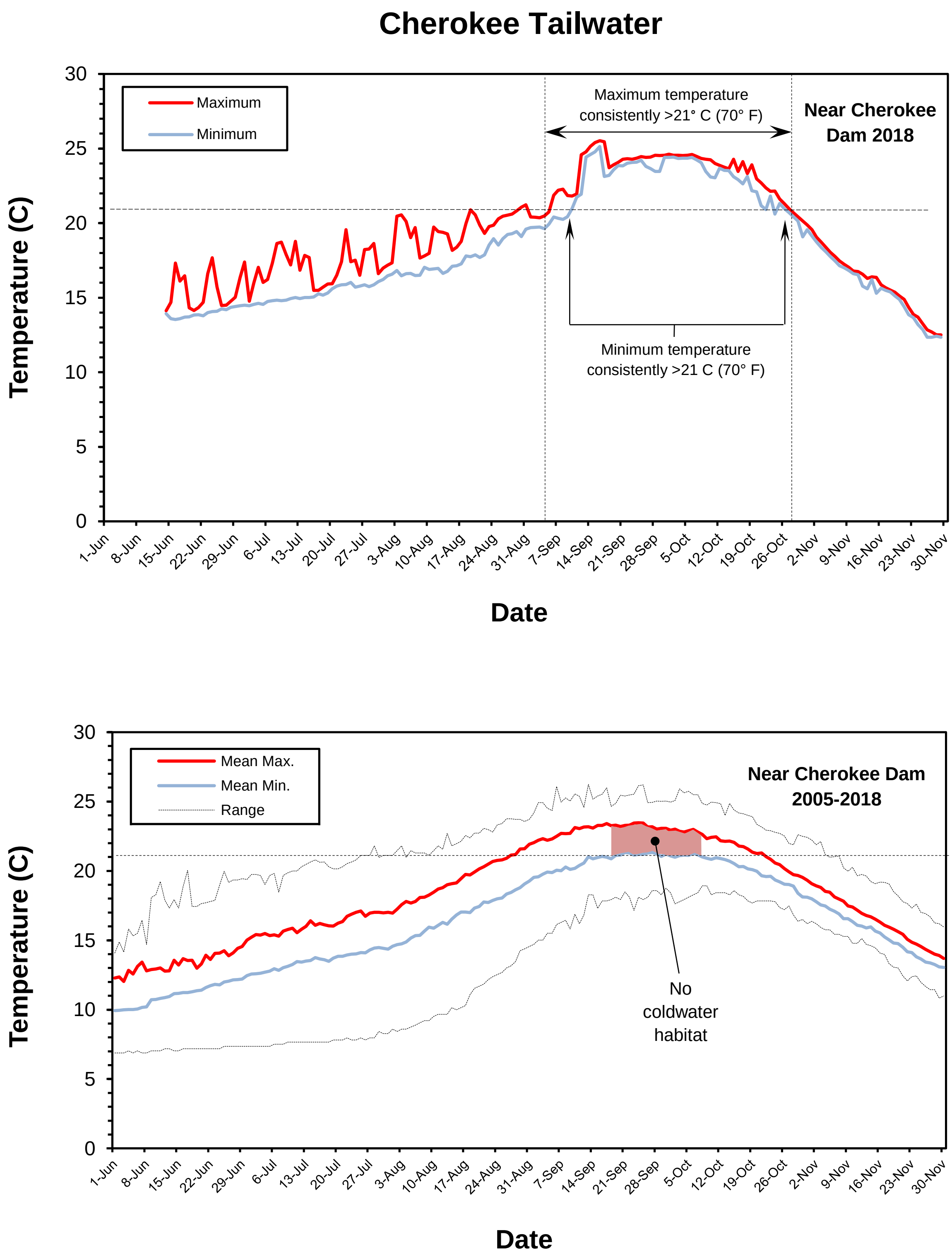
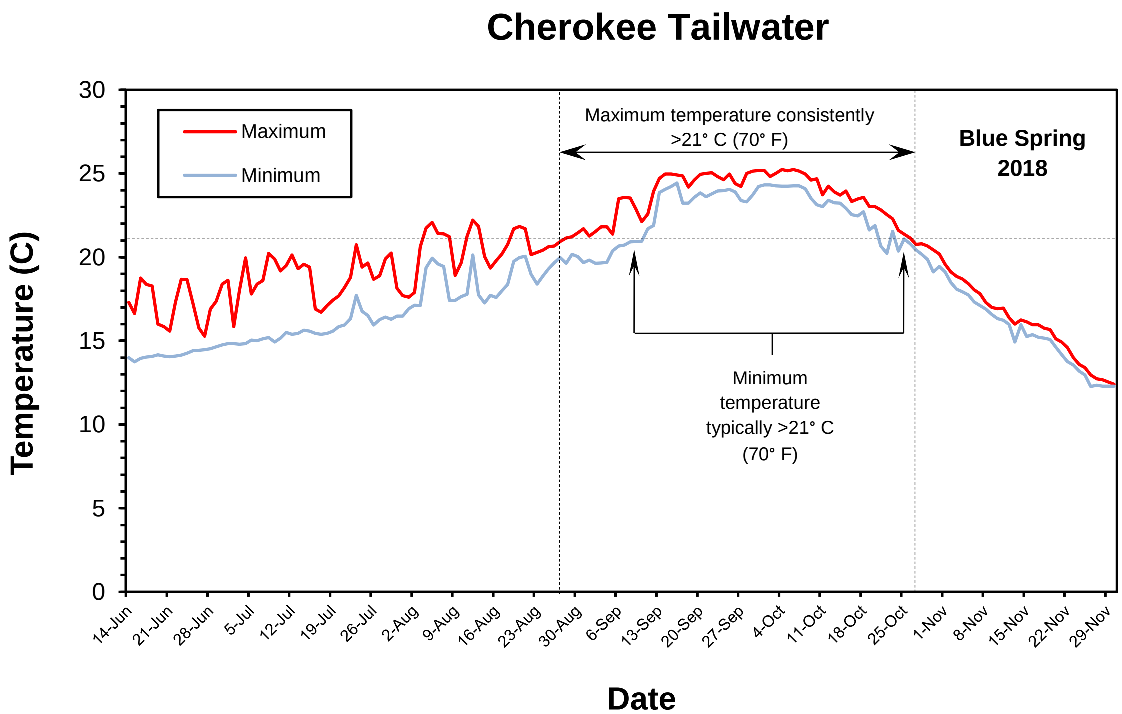


Figure 3-13. Daily temperature maxima and minima for June-November near Cherokee Dam (~1.6 km below the dam) in 2018 (upper graph) and 2005-2018 means (lower graph, with range).



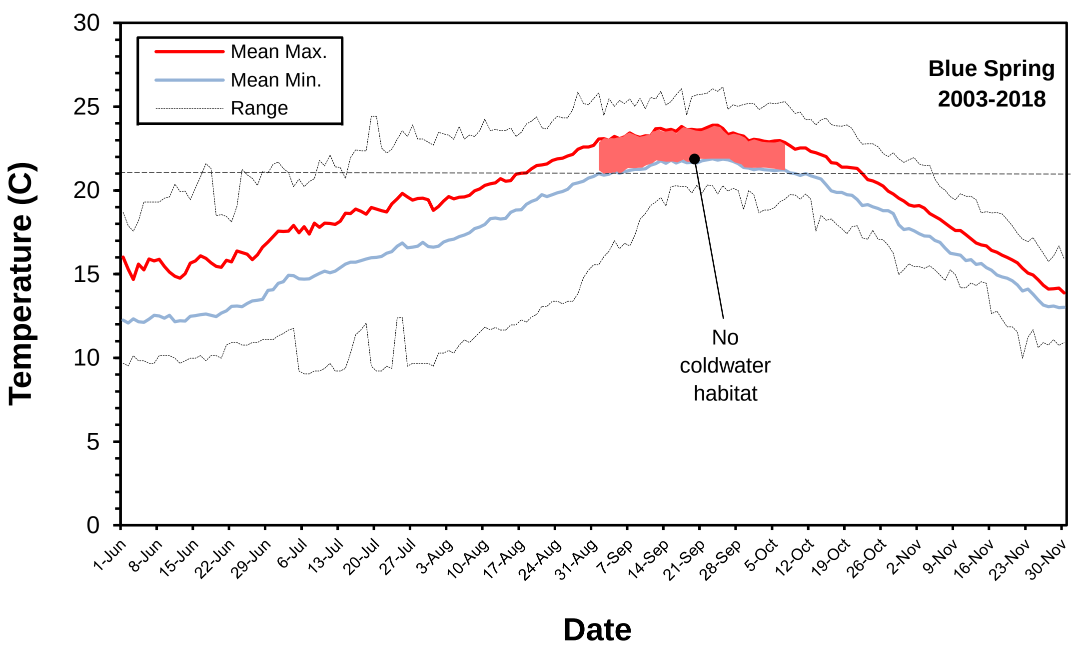


Figure 3-14. Daily temperature maxima and minima for June-November at Blue Spring (~13 km below the dam) in 2018 (upper graph) and 2003-2018 means (lower graph, with range).

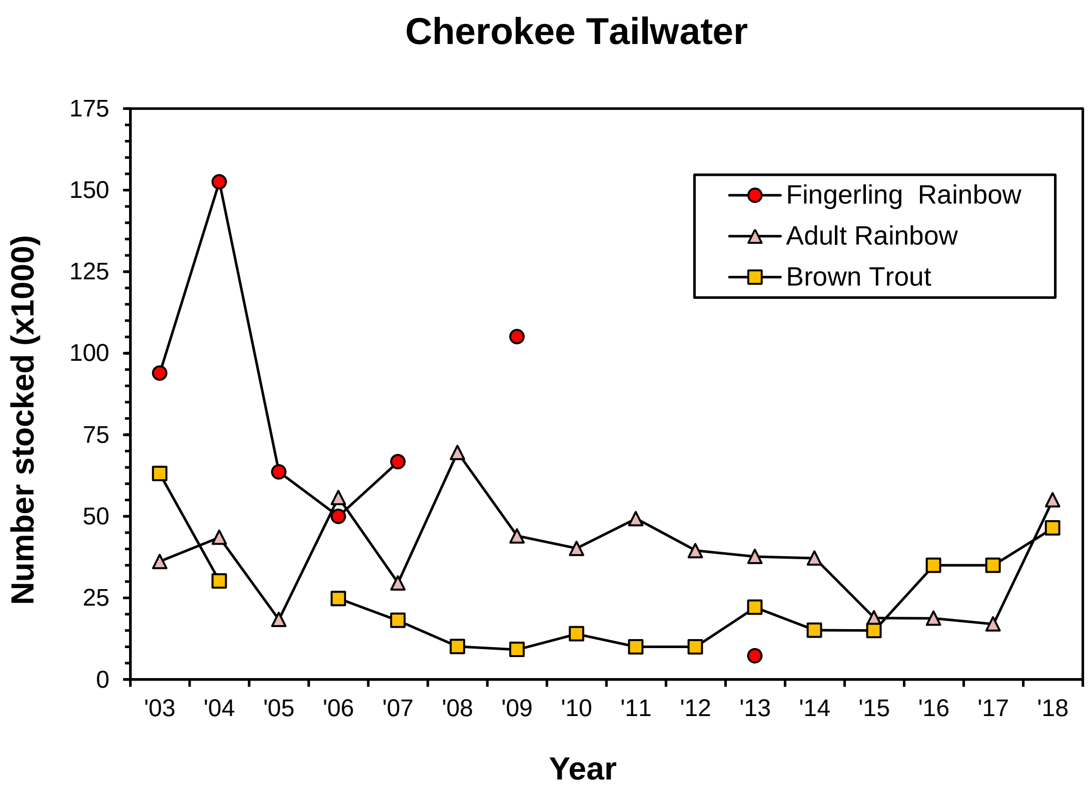


Figure 3-15. Recent trout stocking rates for the Cherokee tailwater. About 29,000 adult Rainbow Trout and 29,000 Brown Trout have been stocked annually since 2014.

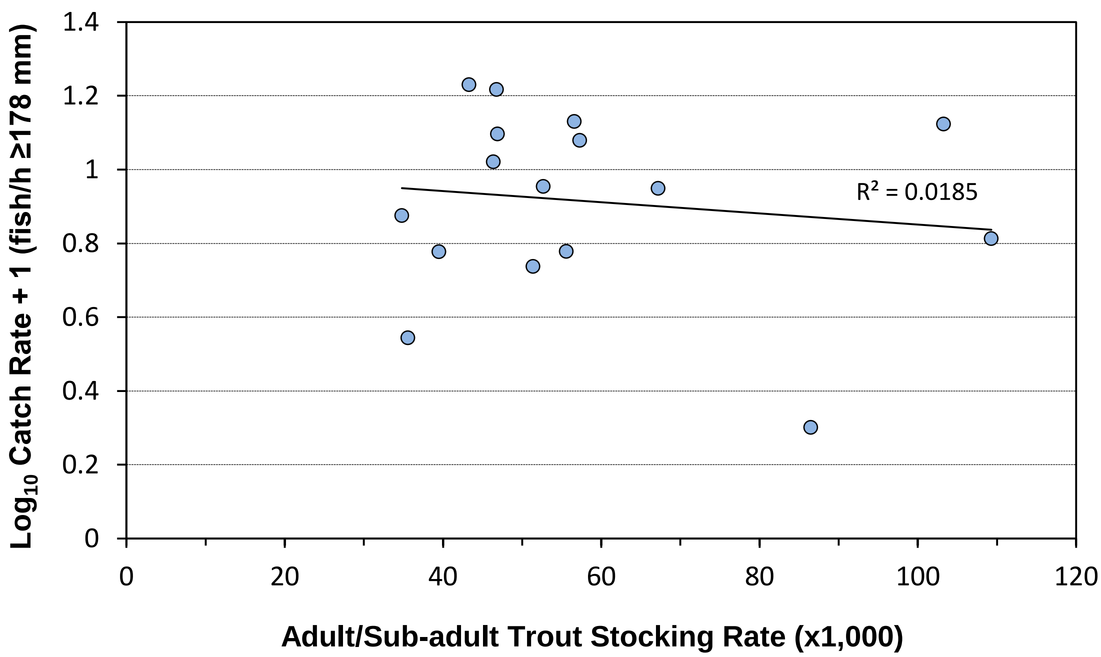


Figure 3-16. Relationship between adult/subadult trout stocking rates (Rainbow Trout and Brown Trout) during October-May and subsequent fall electrofishing catch rates for the Cherokee tailwater.

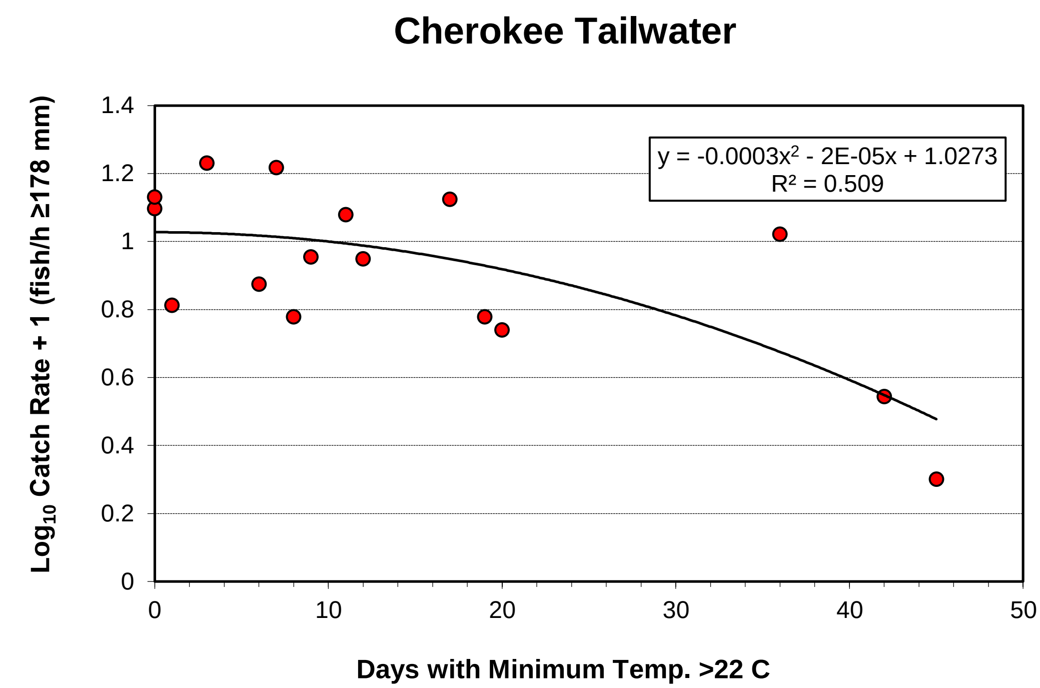


Figure 3-17. Inverse relationship between temperature (days during June-Oct. with minimum >22 C at Blue Spring) and October electrofishing catch rate for the Cherokee tailwater.

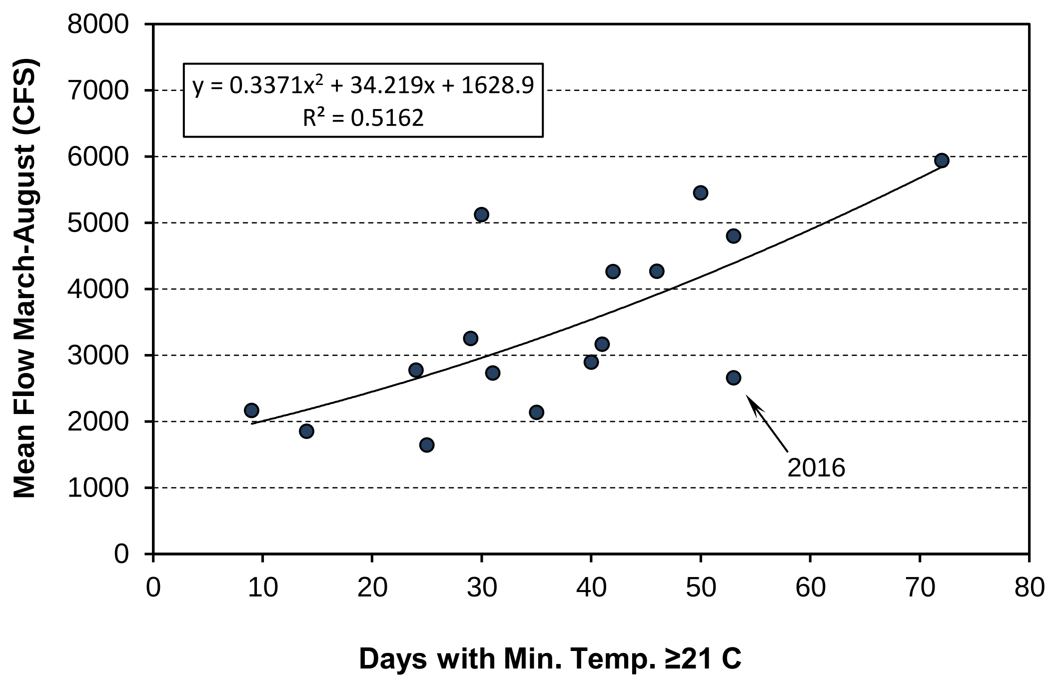


Figure 3-18. Relationship between mean flow (March-August) and temperature (days during June-October with minimum ≥21 C at Blue Spring) for the Cherokee tailwater.

3.2.3 Wilbur (Watauga River)

Study Area

The Watauga River originates in the mountains of northwestern North Carolina and is impounded near Hampton, Tennessee (Carter County), forming Watauga Reservoir (2,603 ha). Most of the reservoir's watershed (1,213 km^2) is forested and much of the Tennessee portion lies within the CNF. Wilbur Dam is located 4.2 km (~2.6 mi.) downstream of Watauga Dam and impounds a small (29 ha or 72 acre) reservoir. The dam was completed in 1912 and is the second oldest in the TVA system (Ocoee No. 1 is the oldest). Despite its long history of degradation (Bivens 1988), the Watauga River between Elizabethton and Boone Reservoir supported one of the finest trout fisheries in the state by the 1990's through a combination of TVA's water quality improvements and TWRA's stocking program.

Bettoli (1999) estimated that the capacity of the Wilbur tailwater to overwinter trout (122 kg/ha) was second only to the South Holston tailwater. The trout fishery in the 16-km (10-mile) river section downstream of Elizabethton was severely damaged by toxic runoff associated with a fire at the North American Corporation in February 2000 (Habera et al. 2001b). Restoration of the trout fishery began immediately and was complete by 2005 (Habera et al. 2006).

The Wilbur tailwater currently supports a 26-km (16-mi.) fishery for Rainbow Trout and Brown Trout. Surface area of the tailwater at base flow is 135 ha (Bettoli 1999). Put-and-take and put-and-grow fisheries are provided by annually stocking fingerling and adult Rainbow Trout. Additionally, successful natural reproduction (Banks and Bettoli 2000; Holbrook and Bettoli 2006) has led to the development of a substantial wild Brown Trout fishery, particularly in the upper half of the tailwater. Brown Trout stocking was discontinued throughout the tailwater in 2015. General trout angling regulations apply except in a 'Quality Zone' (QZ) extending 4.2 km (2.6 mi.) between Smalling Bridge and the CSX Railroad Bridge near Watauga (Figure 3-19). A two-fish creel limit and 356-mm minimum size limit are in effect within the QZ and only artificial lures are permitted.

Wilbur tailwater.

The 13 monitoring stations on the Wilbur tailwater (Figure 3-19) were sampled on 19 March 2018. The purpose of the additional station (10.5; Figure 3-19) is to help evaluate the QZ (Habera et al. 2015b). Data from this station are used only for comparing electrofishing catch rates inside and outside the QZ. Location and sampling effort details for all stations are provided in Table 3-6.

Results and Discussion

The 12 Wilbur tailwater monitoring stations produced 512 trout weighing over 113 kg in 2018 (Table 3-7). Total catch decreased 21% relative to 2017, primarily as the result of lower numbers of Brown Trout (an average of ~12/station) captured in the upper portion of the tailwater (Stations 1-7; Figure 3-19 and Table 3-7). Total biomass for the 2018 sample decreased 22%, reflecting the decrease in overall catch. Brown Trout represented 81% of the total catch in 2018 after reaching 80% in 2017. Bettoli (1999) estimated that Brown Trout represented 60% of overwintering trout density in the Wilbur tailwater during 1998-1999 and Brown Trout relative abundance averaged 70% (range, 65-76%) during 2002-2016. Most Brown Trout (81%) and Rainbow Trout (83%) in 2018 were in the 178-330 mm size range (Figure 3-20) and were most likely age-1 and age-2 fish.

Wild Brown Trout from the upper Wilbur tailwater.

The mean catch rate for all trout ≥178 mm nearly reached 300 fish/h in 2017, but dropped back to 235 fish/h in 2018 primarily as a result of a decrease in the Brown Trout catch rate (Figure 3-21). The current Wilbur tailwater management plan (Habera et al. 2015b) prescribes developing a wild Brown Trout fishery throughout the tailwater by discontinuing all Brown Trout stocking. This strategy will be considered successful if a mean Brown Trout catch rate of 40 fish/h (≥178 mm) can be maintained in the lower portion of the tailwater (Stations 8-12) during 2015-2020 (Habera et al. 2015b). The 2018 Brown Trout catch rate in that area was 49 fish/h and has averaged 47 fish/h since 2015.

The mean catch rate for larger trout (≥356 mm) exceeded 20 fish/h again in 2018 and has been in the 20-27 fish/h range since 2010 (Figure 3-21). The mean catch rate for the largest trout (≥457 mm) increased to 5.5 fish/h in 2018—the highest level since 2011 (7.5 fish/h; Figure 3-21). Most of the trout in this size range are Brown Trout; only nine Rainbow Trout ≥457 mm have been captured to date, although two were collected in 2018. Weiland and Hayward (1997) observed that failure of Rainbow Trout to reach large sizes in some tailwaters may be related to diet overlap among size class and limited capacity to intra-specifically partition food resources (in contrast to Brown Trout). Dodrill et al. (2016) found that prey size, as well as abundance and quality, limits maximum size for drift-foraging Rainbow Trout in tailwaters. Bioenergetically, larger Rainbow Trout would prefer to select larger prey items, but these can be scarce in tailwater systems (Dodrill et al. 2016). Flinders and Magoulick (2017) observed that large Rainbow Trout (>400 mm) in Arkansas tailwaters experienced a food-availability bottleneck during winter that caused daily ration to fall below minimum maintenance requirements, even with lower water temperatures and reduced metabolic costs.

Recently (since 2015), mean catch rates for trout ≥356 mm in the QZ (Stations 10, 10.5, and 11) have been somewhat higher than corresponding catch rates at the other 10 stations. (Figure 3-22). However, there has been substantial overlap of the 90% confidence limits for both areas in most years (Figure 3-22) because of substantial catch rate variability among the QZ sites related to habitat quality. These data provide no clear indication that the QZ regulations are enhancing abundance of larger trout in that area, although they do suggest a general increase in the electrofishing catch rate of trout ≥356 mm throughout the tailwater since 2005. The most recent angler harvest rate for the Wilbur tailwater was relatively low (0.94 fish/trip, see below), but separate data were not available for the QZ. However, focusing harvest on larger trout size classes through minimum length limits (rather than protecting them) may actually promote recruitment and growth overfishing (Sánchez-Hernández 2016) and thereby limit attainment of management objectives.

Wilbur tailwater anglers have recently expressed concerns that Striped Bass *Morone saxatilis* predation could be impacting trout abundance in the lower half of the Wilbur tailwater when they occupy that area during the summer months. This concern has been heightened since the extended drawdown of Boone Lake, which began in 2015. Consequently, a qualitative electrofishing survey was conducted on 11 September 2018 at base flow to evaluate the threat posed by Striped Bass in that area. Six Striped Bass were observed in the 6.5-km reach between the Blevins Bend and Hwy. 400 access areas, along with several large (>508 mm) Brown Trout—which are also predatory on smaller trout. Mean electrofishing catch rates for the lower portion of the tailwater (below Blevins Bend; Stations 9, 10, 10.5, 11, and 12) since 2010 are provided in Figure 3-23. Although catch rates for all trout ≥178 mm were somewhat higher in 2010 and 2011 (126-161 fish/h), they have remained in the 72-109 fish/h range since 2013 and indicate no particular trend (Figure 3-23). Additionally, no trend is evident for catch rates of larger trout (≥356 mm) at these stations during 2010-2018 (range, 19-35 fish/h; Table 3-23).

The Wilbur tailwater was stocked with 41,000 adult Rainbow Trout during 2018 (Figure 3-24) as basically directed in the current management plan (Habera et al. 2015b). The prescribed annual fingerling Rainbow Trout stocking rate is 50,000, but the Erwin National Fish Hatchery stocked an additional 15,000 of their surplus fingerlings as well in 2018 (Figure 3-24). Brown Trout stocking was discontinued in 2015 and Brook Trout stocking was discontinued in 2009 (after eight years) because of extremely low survival (0.1 – 4.4% over 100 d), slow growth (4-15 mm per month), and excessive predation by Brown Trout (Damer and Bettoli 2008).

Roving creel surveys on the Wilbur tailwater were conducted by TWRA in 2013 (Black 2014), 2016 (Black 2017), and again in 2018. Data for the 2018 survey will be available for inclusion in the 2019 report. The 2016 survey indicated that pressure, trips, and mean trip length, along with estimated catch and harvest increased substantially since 2013:

Year	Pressure (h)	Mean Trip length (h)	Trips	Catch[a]	Harvest[a]
2013	61,764	3.88	15,909	103,233 (68)	14,234 (86)
2016	112,627	4.90	22,965	213,673 (71)	21,477 (88)

[a]Values in parentheses are percentages represented by Rainbow Trout.

The average trout catch rate also increased from 1.67 fish/h in 2013 to 1.90 fish/h in 2016, while average catch per trip increased from 6.5 in 2013 to 9.3 per trip in 2016. By comparison, catch rates over 0.7 fish/h are generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). The angler harvest rate decreased from 14% in 2013 to 10% in 2016, with average harvest below 1 fish/trip in 2013 (0.89 fish/trip) and 2016 (0.94/trip). Rainbow Trout and Brown Trout abundance were relatively stable during 2013-2016 (Figure 3-21), and proportions of both species represented in catch and harvest estimates remained relatively unchanged.

A majority of Wilbur tailwater anglers interviewed in 2013 (67%) expressed their support for the QZ regulations and 60% opposed replacing it with a tailwater-wide PLR (slot limit) with no bait restrictions (Habera et al. 2014a). A substantial majority (98%) also rated TWRA's management of the Wilbur tailwater trout fishery as good or excellent at that time. In 2016, 44% of anglers who had fished the QZ since 2013 indicated that they did catch more large (≥356 mm) trout there. While a majority of anglers did not experience a higher catch rate for large trout in the QZ, most (81%) did not support changing to a PLR-type regulation there. This opinion differed little between those who did catch more large fish in the QZ (83% un-supportive) and those who did not (80% unsupportive).

The parasite that causes whirling disease (*Myxobolus cerebralis*) was detected in both Rainbow Trout and Brown Trout from the Wilbur tailwater as a result of screening efforts in 2017 (Habera et al. 2018a). Consequently, TWRA moved forward with information and education (I&E) efforts directed at preventing the spread of spores and infected fish. To judge the effectiveness of the I&E campaign, anglers were asked during 2018 creel survey interviews if they were aware that *M. cerebralis* was present in Wilbur tailwater trout and if so, how they learned about it. Overall, 60% of the 204 anglers interviewed indicated that they were aware of the presence of the whirling disease parasite. The proportion of anglers that were aware increased somewhat from the early months of the survey (47-56%) to the end of the survey (65-70%, October-December). The Agency's Fishing Guide was cited by 66% of anglers who were aware of the presence of the whirling disease parasite as the source of their information. Sixteen percent learned from other anglers, 11% learned from the Agency's website, and 7% learned from other sources. No one cited the Agency's webcast as their information source.

Management Recommendations

The goal of the current (2015-2020) Wilbur tailwater management plan is to maintain a quality trout fishery throughout the tailwater capable of providing a variety of opportunities to the anglers who enjoy this resource (Habera et al. 2015b). Two of its basic objectives—managing for a wild Brown Trout fishery throughout the tailwater and maintaining Rainbow Trout stocking rates (along with the Rainbow Trout fishery)—are being achieved. The third—consideration of a regulation change in the QZ to a PLR—has also been addressed and currently most anglers do not support a regulation change (e.g., to a PLR), even if they do not experience higher catch rates for larger trout. Therefore, no change is recommended.

Wilbur Tailwater

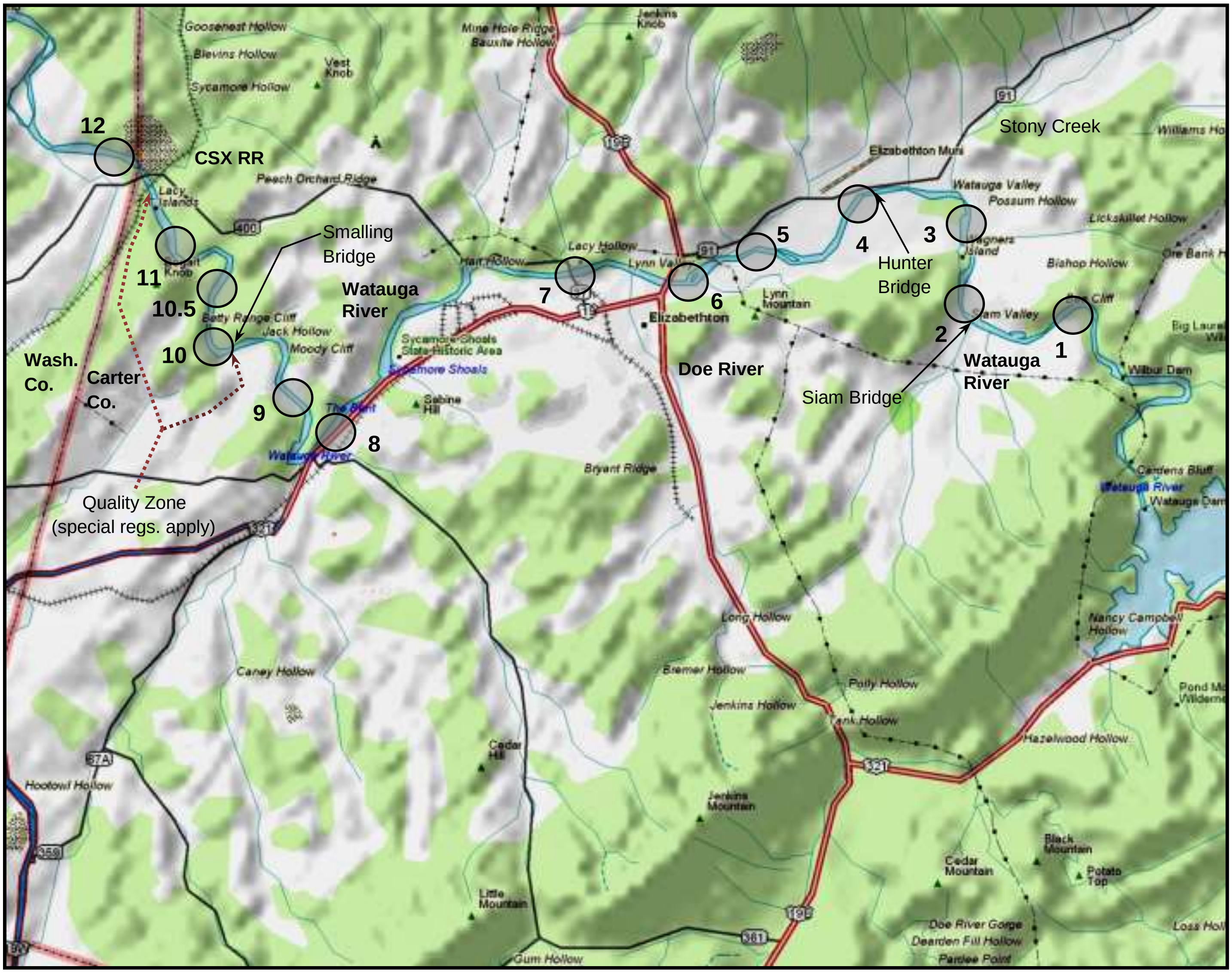


Figure 3-19. Locations of the Wilbur tailwater (Watauga River) monitoring stations. Station 10.5 was added in 2010 to help evaluate the Quality Zone (which also includes stations 10 and 11).

Table 3-6. Location and sampling information for the 13 electrofishing stations on the Wilbur tailwater, 19 March 2018.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420180401	Carter	Elizabethton 207 SW	36.35194N-82.13306W	06010103-19,0	33.0	600	400 V DC 120 PPS, 4 A
2	420180402	Carter	Elizabethton 207 SW	36.34806N-82.14861W	06010103-19,0	32.0	600	884 V DC 120 PPS, 5 A
3	420180403	Carter	Elizabethton 207 SW	36.36361N-82.15444W	06010103-19,0	30.3	600	400 V DC 120 PPS, 4 A
4	420180404	Carter	Elizabethton 207 SW	36.36833N-82.16861W	06010103-18,0	29.5	600	884 V DC 120 PPS, 5 A
5	420180405	Carter	Elizabethton 207 SW	36.35833N-82.17944W	06010103-18,0	28.4	600	400 V DC 120 PPS, 4 A
6	420180406	Carter	Elizabethton 207 SW	36.35500N-82.20333W	06010103-18,0	27.0	600	884 V DC 120 PPS, 5 A
7	420180407	Carter	Elizabethton 207 SW	36.36028N-82.22694W	06010103-12,2	25.9	600	400 V DC 120 PPS, 4 A
8	420180408	Carter	Johnson City 198 SE	36.33222N-82.26694W	06010103-12,2	22.4	600	884 V DC 120 PPS, 5 A
9	420180409	Carter	Johnson City 198 SE	36.33389N-82.26917W	06010103-12,0	21.8	600	400 V DC 120 PPS, 4 A
10	420180410	Carter	Johnson City 198 SE	36.34556N-82.28306W	06010103-12,0	20.0	600	884 V DC 120 PPS, 5 A
10.5	420180411	Carter	Johnson City 198 SE	36.35150N-82.28730W	06010103-12,0	19.4	600	400 V DC 120 PPS, 4 A
11	420180412	Carter	Johnson City 198 SE	36.35750N-82.29056W	06010103-10,0	18.7	600	400 V DC 120 PPS, 4 A
12	420180413	Carter	Johnson City 198 SE	36.37361N-82.30250W	06010103-10,0	17.3	600	884 V DC 120 PPS, 5 A

Station 10.5 was added in 2010 to help evaluate the Quality Zone (also includes Stations 10 and 11).

Table 3-7. Catch data for the 13 electrofishing stations on the Wilbur tailwater sampled 19 March 2018.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	11	180-288	1,511	16	11
	Brown	58	114-387	12,392	84	89
Totals		**69**		**13,903**	**100**	**100**
2	Rainbow	10	183-331	1,537	10	9
	Brown	91	120-362	15,076	90	91
Totals		**101**		**16,613**	**100**	**100**
3	Rainbow	8	112-337	828	19	12
	Brown	35	181-481	6,146	81	88
Totals		**43**		**6,974**	**100**	**100**
4	Rainbow	6	205-298	979	9	10
	Brown	60	112-399	9,098	91	90
Totals		**66**		**10,077**	**100**	**100**
5	Rainbow	14	159-900	3,874	15	21
	Brown	80	126-430	14,617	85	79
Totals		**94**		**18,491**	**100**	**100**
6	Rainbow	4	205-267	491	11	8
	Brown	34	111-392	5,328	89	92
Totals		**38**		**5,819**	**100**	**100**
7	Rainbow	4	178-295	636	18	12
	Brown	18	148-390	4,836	82	88
Totals		**22**		**5,472**	**100**	**100**
8	Rainbow	12	240-384	2,913	50	29
	Brown	12	275-554	7,306	50	71
Totals		**24**		**10,219**	**100**	**100**
9	Rainbow	7	230-300	1,313	54	33
	Brown	6	277-420	2,682	46	67
Totals		**13**		**3,995**	**100**	**100**
10	Rainbow	9	230-438	3,277	82	58
	Brown	2	352-530	2,354	18	42
Totals		**11**		**5,631**	**100**	**100**
-						
10.5	Rainbow	7	207-367	1,820	64	32
	Brown	4	301-526	3,098	36	55
Totals		**11**		**4,918**	**100**	**87**
11	Rainbow	9	201-422	3,819	38	34
	Brown	15	256-491	7,331	63	66
Totals		**24**		**11,150**	**100**	**100**
12	Rainbow	2	323-380	996	29	20
	Brown	5	331-574	3,896	71	80
Totals		**7**		**4,892**	**100**	**100**
Total Rainbows[1]		96	112-500	22,174	19	20
Total Browns[1]		416	111-574	91,062	81	80
Overall totals[1]		**512**		**113,236**	**100**	**100**

[1]Overall totals do not include Station 10.5, which was added in 2010 to help evaluate the Quality Zone (stations 10, 10.5, and 11 are in the QZ).

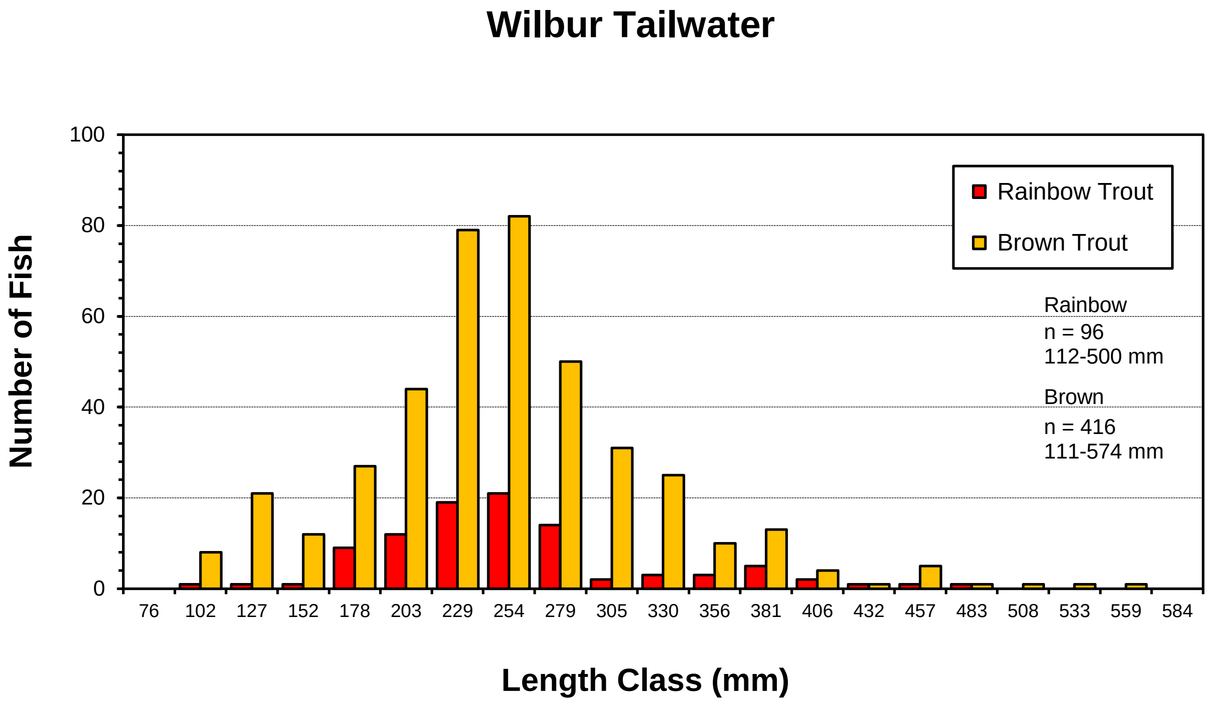


Figure 3-20. Length frequency distributions for trout from the Wilbur tailwater monitoring stations in 2018 (excluding Station 10.5).

Wilbur Tailwater

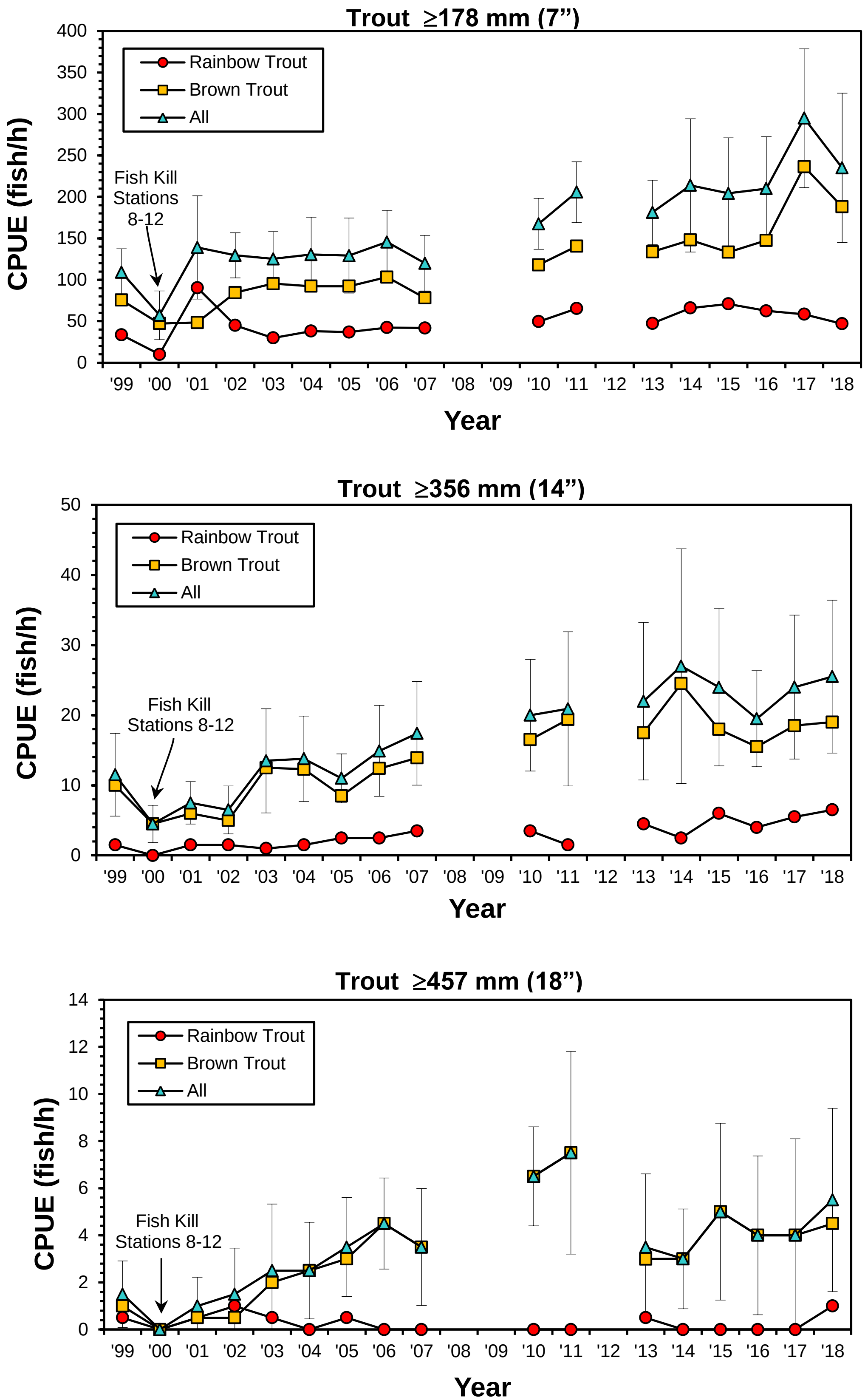


Figure 3-21. Mean trout CPUEs for the Wilbur tailwater samples. Bars indicate 90% confidence intervals.

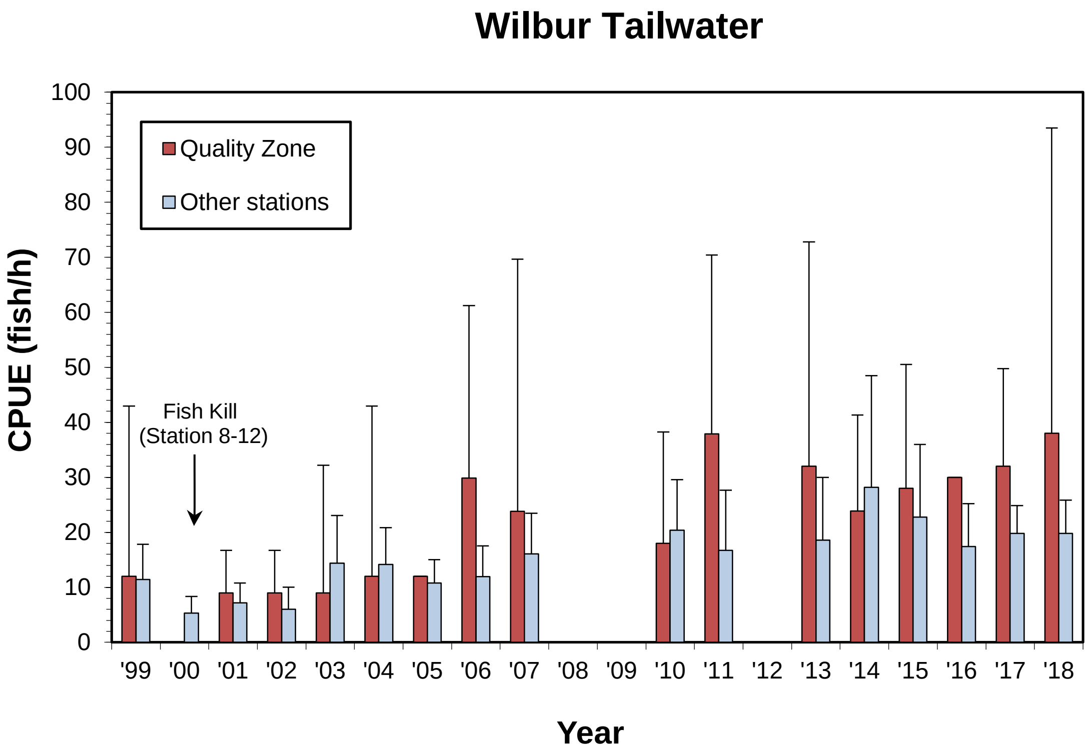


Figure 3-22. Mean trout CPUEs for trout ≥356 mm from the Quality Zone (QZ; stations 10, 10.5, and 11) and the other 10 stations on the Wilbur tailwater. Bars indicate 90% upper confidence limits.

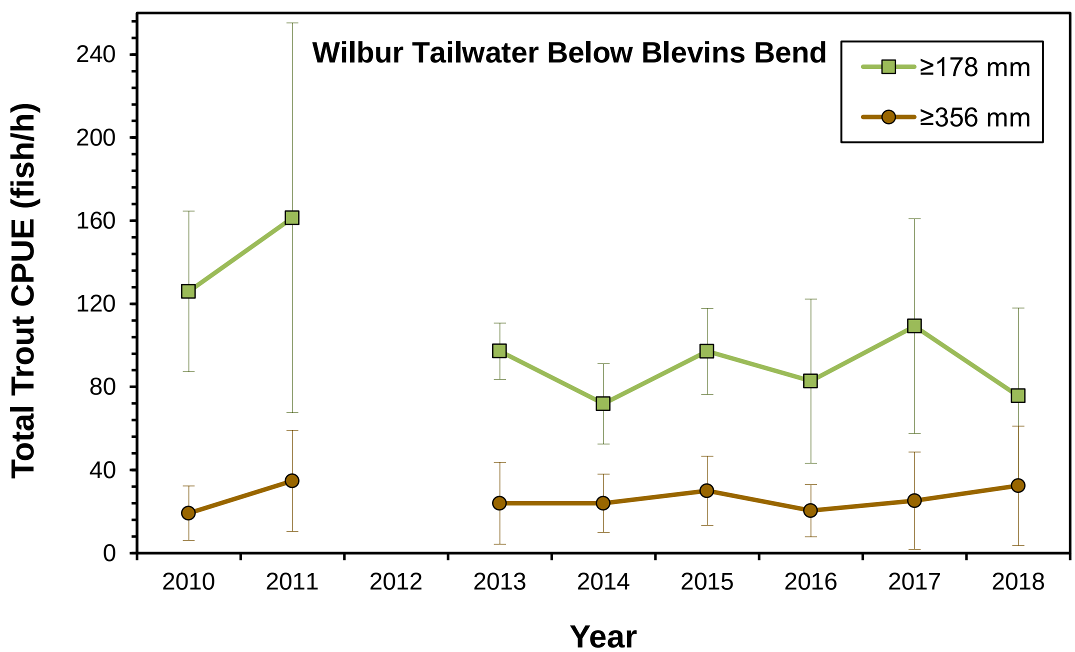


Figure 3-23. Mean trout CPUEs for stations 9, 10, 10.5, and 11 (below Blevins Bend, including the Quality Zone) on the lower Wilbur tailwater. Bars indicate 90% upper confidence limits.

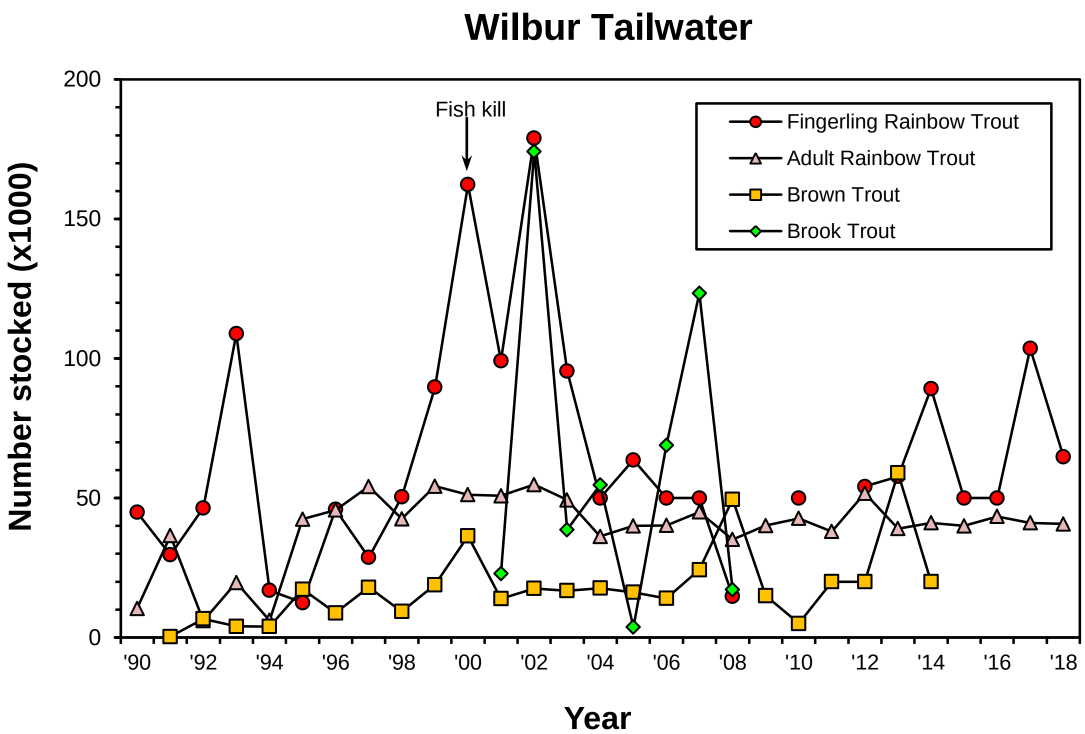


Figure 3-24. Recent trout stocking rates for the Wilbur tailwater. Stocking rates under the current management plan (2015-2020) are 40,000 adult and 50,000 fingerling Rainbow Trout annually.

3.2.4 Fort Patrick Henry (South Fork Holston River)

Study Area

Ft. Patrick Henry Dam impounds a small (362 ha) reservoir (Ft. Patrick Henry Lake) on the South Fork of the Holston River near Kingsport. TVA maintains a minimum flow of 11.3 m^3/s (400 cfs) downstream of the dam, where the river provides an important industrial water supply. The upper 4.7 km (2.9 mi.) of the Ft. Patrick Henry tailwater (Figure 3-25) is managed as a put-and-take and put-and-grow trout fishery with annual stockings of adult and fingerling Rainbow Trout and sub-adult (152-178 mm) Brown Trout. Sample site locations and effort details are summarized in Table 3-8.

Results and Discussion

The four Ft. Patrick Henry tailwater electrofishing stations produced 45 trout weighing over 36 kg in 2018 (Table 3-9). Trout catch and biomass decreased relative to the 2017 totals (61% and 40%, respectively). Fewer Rainbow Trout—particularly fish in the 254-279 mm and ≥356 mm size classes—caused the decrease. Brook Trout have been captured only once in previous samples (one fish in 2013), but 13 were captured in 2018 (Table 3-9). All of those were in the 254-305 mm size classes (Figure 3-26) and may have passed down from the Boone tailwater/Ft. Patrick Henry Lake, as none were stocked in the Ft. Patrick Henry tailwater in 2017 or early 2018. Rainbow Trout ranged from 220-583 mm and fish in the 356-432 mm (14-17 in.) size classes were most abundant (Figure 3-26). The 2018 sample included only four Brown Trout, but one of these was the largest specimen captured to date (735 mm or 28.9 in.; Figure 3-26). Previously, only one Brown Trout ≥600 mm had been captured (2013) and overall, only six fish ≥508 mm (20 in.) have been taken in Ft. Patrick Henry tailwater monitoring samples. By contrast, 58 Rainbow trout ≥508 mm have been captured since monitoring began in 2002. Mean relative weight (W_r) was 111 (SE=4.41) for Rainbow Trout and 102 (SE=4.09) for Brown Trout from the 2018 sample.

Ft. Patrick Henry tailwater sampling.

The mean catch rate for all trout ≥178 decreased to 44 fish/h in 2018 (Figure 3-27), which is a 58% decline from 2017 and well below the long-term average of 75 fish/h. Without the atypical contribution by Brook Trout (13 fish/h), the overall catch rate for 2018 would have been the lowest recorded to date (31 fish/h). Mean catch rates for trout ≥356 mm and ≥457 mm also decreased in 2018 to 27 fish/h and 7 fish/h, respectively (Figure 3-27) and fell below the correspond long-term averages (30 fish/h and 10 fish/h, respectively). The abundance of trout ≥457 mm had been substantially depressed during 2004-2010 (0 to 4 fish/h), but has improved since then, averaging 16 fish/h (Figure 3-27). The relative stock density for Rainbow Trout ≥457 mm or 18 in. (RSD-18) regularly reaches or exceeds 20 (Figure 3-28). An RSD-18 value of 20 indicates that 20% of all stock-size trout—i.e., those at least 254 mm (10 in.) in length—are 457 mm (18 in.) or larger. This is a significant and valuable attribute of the Ft. Patrick Henry tailwater Rainbow Trout fishery, as mean RSD-18 values for Rainbow Trout in other Region 4 tailwaters (except Boone) are <5. Mean RSD-18 for Ft. Patrick Henry tailwater Rainbow Trout has averaged 23 since 2011 and increased slightly in 2018 (Figure 3-28).

Ft. Patrick Henry tailwater stocking rates have been more stable since 2008, although about 19,000 surplus Rainbow Trout fingerlings were stocked in 2018 (Figure 3-29). Overall, 10,500 adult Rainbow Trout, 26,500 fingerling Rainbow Trout, and 25,000 Brown Trout were stocked in 2018 (Figure 3-29). Stocking rates for the previous five years have averaged 11,000 adult Rainbow Trout, 10,500 fingerling Rainbow Trout, and 20,500 Brown Trout (Figure 3-29).

A roving creel survey was conducted on the Ft. Patrick Henry tailwater by TWRA in 2017 (Black 2018). Nearly all anglers (99.6%) indicated they were fishing for trout, although a few said they were targeting Smallmouth Bass *Micropterus dolomieu*. Trout anglers fished an estimated 13,423 h while making 4,278 trips (3.14 h/trip; see table below). Trout anglers caught an estimated 16,481 trout (93% Rainbow Trout, 7% Brown Trout) and harvested 3,934 (95% Rainbow Trout). The average trout catch rate was 1.2 fish/h (3.8 fish/trip), with catch rates >0.7 fish/h generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). The trout harvest rate was 24% (0.9 fish/trip) and 95% of harvested fish were Rainbow Trout. Most anglers (94%) were from Sullivan, Hawkins, and Washington counties. Pressure, trips, catch, and harvest for the Ft. Patrick Henry tailwater were below the corresponding estimates for the most recent surveys of the larger Norris, Wilbur, and South Holston tailwaters (see sections 3.2.1, 3.2.3, and 3.2.6). However, Ft. Patrick Henry trout anglers are more harvest oriented, as their overall trout harvest rate (24%) is about twice the most recent harvest rates for Norris (13%), Wilbur (10%) and South Holston (13%) tailwater anglers.

A 22.3 in., 6.0 lb. Ft. Patrick Henry tailwater Rainbow Trout (W_r =135).

Year	Pressure (h)	Mean Trip length (h)	Trips	Catch[a]	Harvest[a]
2017	13,423	3.14	4,278	16,481 (93)	3,934 (95)

[a]Values in parentheses are percentages represented by Rainbow Trout.

Anglers were also asked during the 2017 creel survey to rate their satisfaction with the Ft. Patrick Henry tailwater trout fishery on a scale of 1 (poor) to 5 (excellent). Interestingly, over one third (37%) of the 276 anglers responding to this question offered no opinion, and several mentioned that they did not know what TWRA does to manage the fishery. The majority (57%), however, rated the fishery as good or excellent.

Management Recommendations

Despite its relatively small size, the Ft. Patrick Henry tailwater provides an excellent trout fishery that consistently produces large, extremely well-conditioned trout. Consequently, a management plan for the Boone and Ft. Patrick Henry tailwaters for 2019-2024 has been developed (Habera et al. 2018b). The management goal for the Ft. Patrick Henry tailwater is to fully develop and maintain its potential—particularly for producing the large, well-conditioned Rainbow Trout—thus providing exceptional angling opportunities. TWRA will continue to use put-and-grow and put-and-take Rainbow Trout and Brown Trout fisheries to attain the management goal. The plan addresses Hatchery-Supported Fisheries Goal 1 (Optimize Use of Hatchery Trout), Strategy 5 in TWRA's current Statewide Trout Management Plan (TWRA 2017).

Management plan objectives are to:

1. *Identify and consistently apply optimal trout stocking rates*
2. *Maintain a mean RSD-18 of ≥20 for Rainbow Trout*
3. *Maintain a mean W_r >100 for trout*
4. *Improve public angling access, and*
5. *Educate anglers on potential biosecurity threats to the trout fishery*

The four monitoring stations will be sampled annually to obtain information necessary for evaluating management plan Objectives 1-3. Fingerling Rainbow Trout stocked in 2019 will be marked (by fin clips or coded-wire implants) to help evaluate Objective 1. This fishery is currently subject to statewide trout angling regulations and no changes are recommended at this time.

Ft. Patrick Henry Tailwater

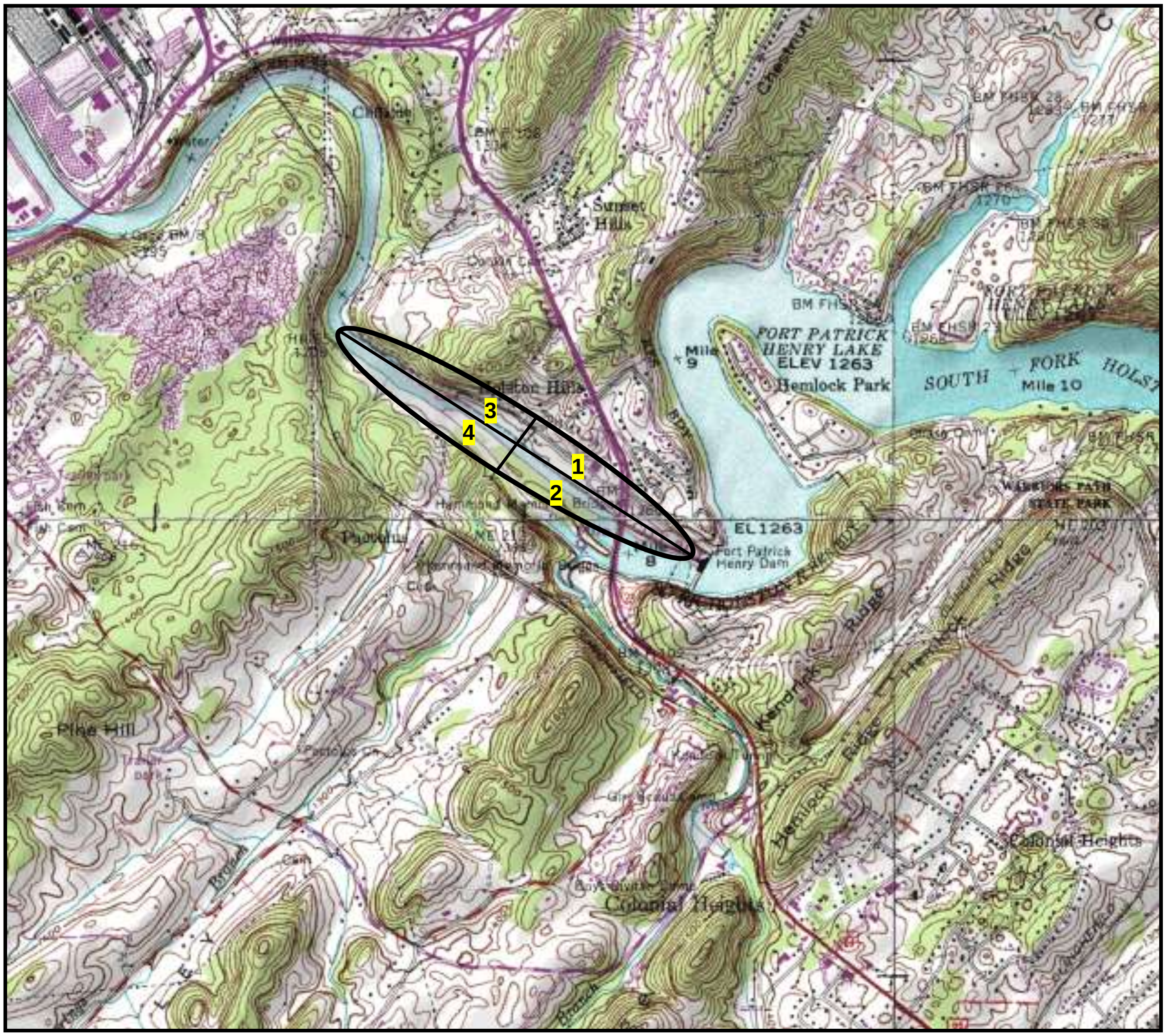


Figure 3-25. Location of the Ft. Patrick Henry tailwater (South Fork Holston River) monitoring stations.

Table 3-8. Location and sampling information for the four stations on the Ft. Patrick Henry tailwater, 7 March 2018.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420180201	Sullivan	Kingsport 188 SE	36.49972N-82.51278W	06010102-4,1	8.0	900	200 V DC 120 PPS, 4 A
2	420180202	Sullivan	Kingsport 188 SE	36.49917N-82.51278W	06010102-4,1	8.0	900	884 V DC 120 PPS, 4-5 A
3	420180203	Sullivan	Kingsport 188 SE	36.50583N-82.52306W	06010102-4,0	7.4	900	200 V DC 120 PPS, 4 A
4	420180204	Sullivan	Kingsport 188 SE	36.50556N-82.52333W	06010102-4,0	7.4	900	884 V DC 120 PPS, 4-5 A

Table 3-9. Catch data for the four electrofishing stations on the Ft. Patrick Henry tailwater sampled 7 March 2018.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow Trout	4	240-540	2,635	57	80
	Brook Trout	3	274-305	668	43	20
Totals		**7**		**3,303**	**100**	**100**
2	Rainbow Trout	5	220-425	3,379	33	32
	Brown Trout	3	155-735	5,089	20	49
	Brook Trout	7	285-324	1,977	47	19
Totals		**15**		**10,445**	**100**	**100**
3	Rainbow Trout	6	256-567	7,086	86	97
	Brook Trout	1	280	213	14	3
Totals		**7**		**7,299**	**100**	**100**
4	Rainbow Trout	13	370-583	14,493	81	93
	Brown Trout	1	383	649	6	4
	Brook Trout	2	266-305	428	13	3
Totals		**16**		**15,570**	**100**	**100**
Total Rainbow Trout		**28**	220-583	**27,593**	62	75
Total Brown Trout		**4**	155-735	**5,738**	9	16
Total Brook Trout		**13**	266-324	**3,286**	29	9
Overall totals		**45**		**36,617**	**100**	**100**

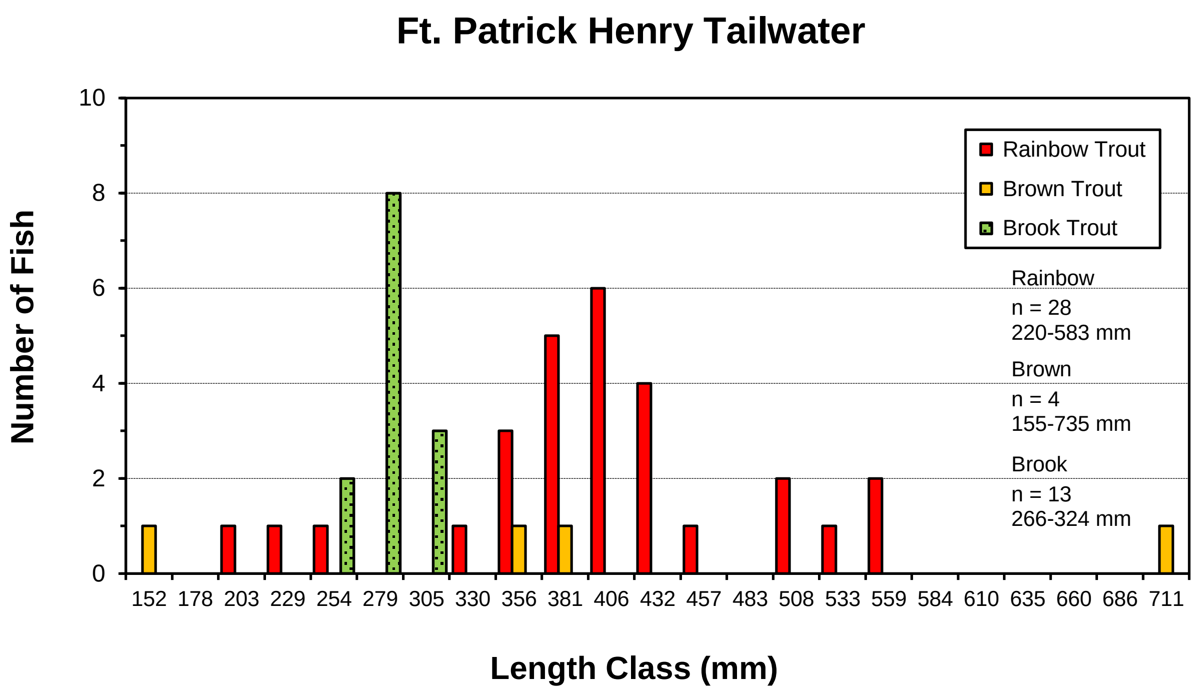


Figure 3-26. Length frequency distributions for trout from the Ft. Patrick Henry tailwater monitoring stations in 2018.

Ft. Patrick Henry Tailwater

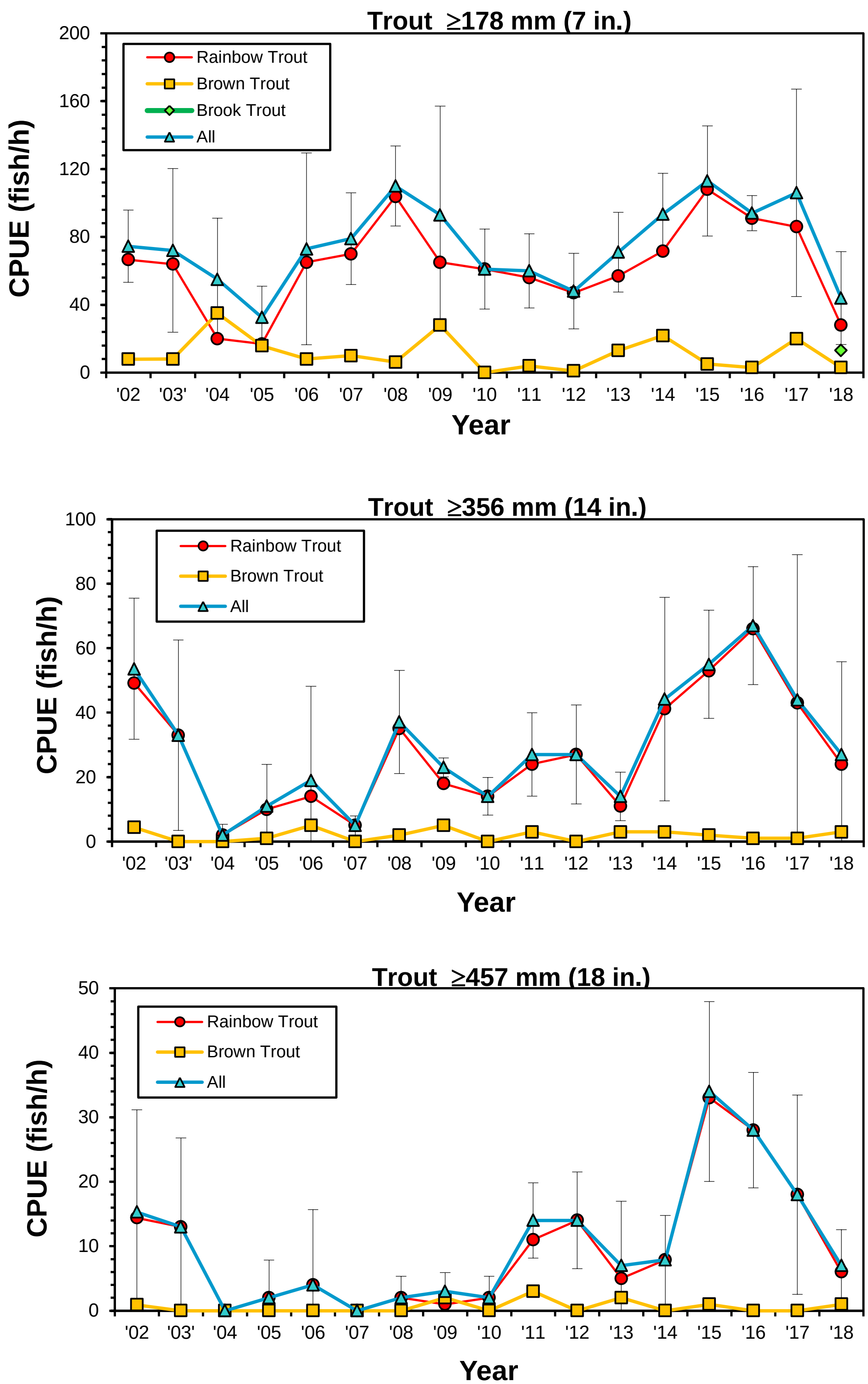


Figure 3-27. Mean trout CPUEs for the Ft. Patrick Henry tailwater samples. Bars indicate 90% confidence intervals.

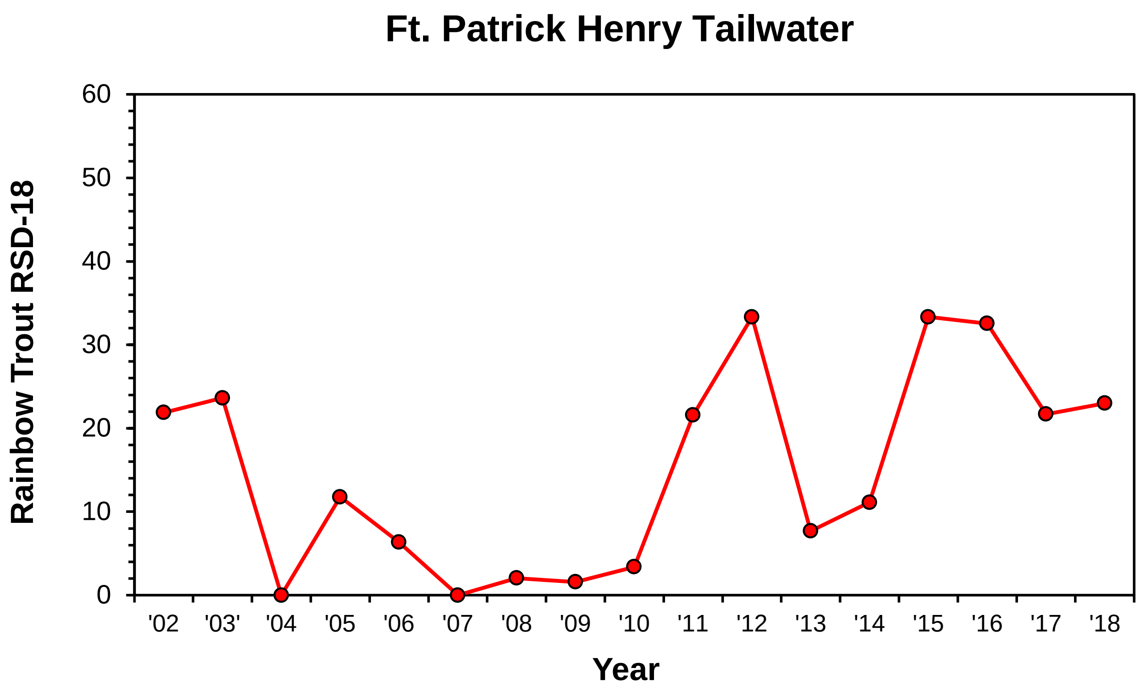


Figure 3-28. RSD-18 for Ft. Patrick Henry tailwater Rainbow Trout (2002-2018).

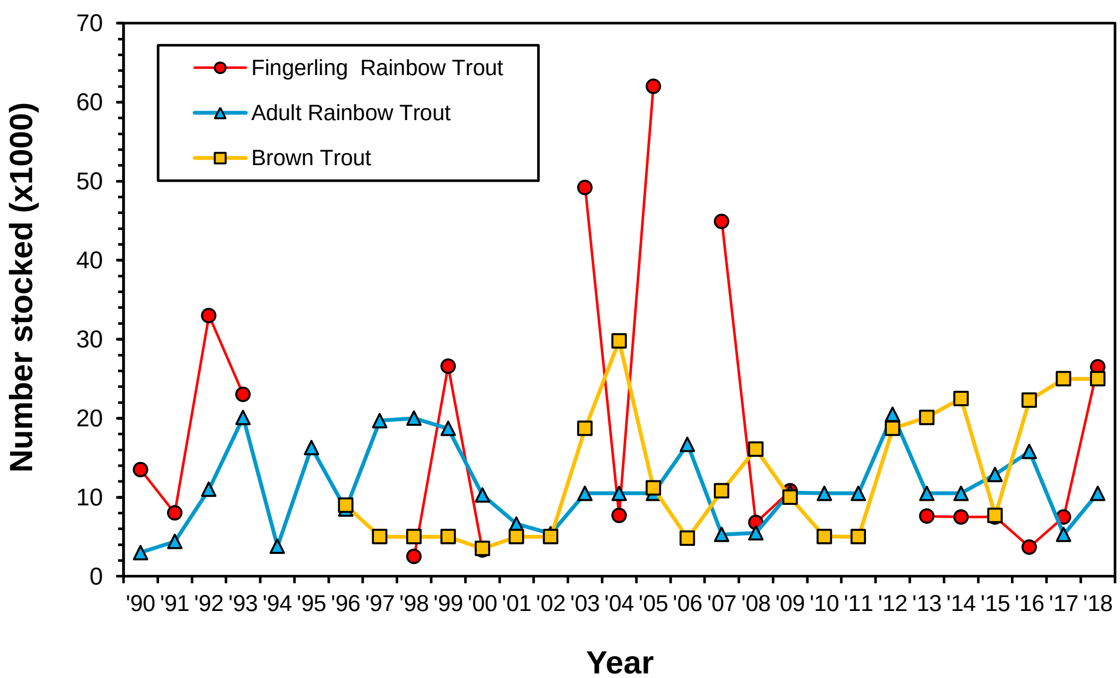


Figure 3-29. Recent trout stocking rates for the Ft. Patrick Henry tailwater. The average annual stocking rate during the past five years (2014-2018) has been 11,000 adult and 10,500 fingerling Rainbow Trout and 20,500 Brown Trout.

3.2.5 Boone (South Fork Holston River)

Study Area

Boone Dam impounds a 1,782 ha (4,400 acre) reservoir (Boone Lake) on the South Fork of the Holston and Watauga rivers in Sullivan and Washington counties near Johnson City and Kingsport. Both the South Holston and Wilbur tailwaters, which support two of Tennessee's premier trout fisheries, flow into Boone Lake. A short (~1 km) tailwater exists downstream of Boone Dam at the upper end of Ft. Patrick Henry Lake. The dam has three autoventing turbines which help improve dissolved oxygen levels in the water released from Boone Dam. This tailwater and Ft. Patrick Henry Lake provide coldwater habitat that was historically stocked with adult Rainbow Trout. TWRA's preliminary investigations of this tailwater in 2008 indicated the presence of a good Rainbow Trout fishery along with a few Brown Trout, which likely were migrants from the South Holston or Wilbur tailwaters upstream. Evidence of some natural reproduction by Rainbow Trout (58-85 mm fish) was also detected in 2008 during sampling at base flow. Accordingly, four electrofishing stations (Figure 3-30) were established in 2008 and the Boone tailwater was added to the annual monitoring program in 2009. Sample site locations and effort details are summarized in Table 3-10.

Boone tailwater.

Results and Discussion

The four Boone tailwater monitoring stations produced 110 trout (41 Rainbow Trout, 21 Brown Trout, and 48 Brook Trout) weighing nearly 33 kg in 2018 (Table 3-11). More Brook Trout were captured in 2018 than in all previous samples combined (n=22) and were the most abundant species in the 2018 sample. Total trout catch was similar to 2017, but catch biomass decreased 33%—primarily as the result of fewer large Brown Trout (>508 mm) in the 2018 sample. Mean Brown Trout weight was 341 g in 2018 vs. 723 g (29 fish) in 2017. There were no Brown Trout larger than the 508-mm size class in 2018 (Figure 3-31), while five (up to 722 mm) were captured in 2017. Brown Trout were added to the stocking program in 2008 and while they have not become abundant, several fish over 600 mm (23.6 in.) have been captured in previous samples, indicating that those browns that do survive have excellent growth potential in this tailwater.

Rainbow Trout have typically exhibited a bimodal size distribution, and the 203-254 mm (8-10 in.) and 330-381 mm (13-15 in.) size classes were most abundant in 2018 (Figure 3-31). No Rainbow Trout ≥406 mm (16 in.) were captured in 2017 (for the first time since 2008), but four were present in the 2018 sample (Figure 3-31). Brook trout have also shown exceptional growth potential in the Boone tailwater (three fish >356 mm or 14 in. have previously been captured), but none >325 mm were captured in 2018 (Figure 3-31). Mean relative weight (W_r) was 104 (SE=2.21) for Rainbow Trout, 99 (SE=1.86) for Brown Trout, and 86 (SE=1.18) for Brook Trout from the 2018 sample.

Although the mean electrofishing catch rate for Rainbow Trout decreased 33% to 41 fish/h in 2018, the catch rate for all trout ≥178 mm (110 fish/h) was relatively unchanged from 2017 because of the abundance of Brook Trout (Figure 3-32). Therefore, the overall catch rate remained above the long-term average of 80 fish/h. The catch rate for trout ≥356 mm declined again to 13 fish/h in 2018—the only time it has been <20 fish/h except for the 2014 sample (Figure 3-32). The catch rate for large (≥457 mm) Brown Trout decreased in 2018, while it increased for large Rainbow Trout, resulting in little overall change relative to 2017 (Figure 3-32). The relative stock density for Rainbow Trout ≥457 mm or 18 in. (RSD-18) regularly reaches or exceeds 10, while RSD-18 often exceeds 20 for all trout (Figure 3-33). An RSD-18 value of 20 indicates that 20% of all stock-size trout—i.e., those at least 254 mm (10 in.) in length—are 457 mm (18 in.) or larger. The potential for high RSD-18s (≥10 for Rainbow trout and ≥10 for all trout) is a significant and valuable attribute of the Boone tailwater fishery. Mean RSD-18 values for Rainbow Trout in other Region 4 tailwaters (except Boone) are <5. Mean RSD-18 has averaged 17 for Rainbow Trout and 23 for all trout in Boone tailwater samples since 2013 (both increased from 2017 to 2018; Figure 3-33).

A large Rainbow Trout captured during 2018 Boone tailwater monitoring.

Historically, only adult Rainbow Trout were stocked in the Ft. Patrick Henry Lake (Boone tailwater) at annually-variable rates, averaging 9,700/year during 1990-2007 (Figure 3-34). Since 2007, adult Rainbow Trout stocking rates have averaged 8,600, with 9,000 were stocked in 2017 (Figure 3-34). Fingerling Rainbow Trout were added to the stocking program in 2008 and have been stocked most years since then, although at variable rates (Figure 3-34). However, the effectiveness fingerling Rainbow Trout stocking here (as in the Ft. Patrick Henry tailwater) has not yet been evaluated. Given the Boone tailwater's potential to produce large fish, Brown Trout were also added to the program in 2008 and since then, ~14,000 (primarily 203 mm) have been stocked annually, including 21,000 in 2018 (Figure 3-34). Brook trout have been stocked occasionally since 2009 (Figure 3-34) and so far have shown limited survival, but good growth potential. Given the abundance of Brook Trout in the 2018 sample, it will be interesting determine if the 2019 sample indicates recruitment into size classes beyond 305 mm.

Repairs to address seepage at the earthen portion of Boone Dam continued in 2018 and have required the extended drawdown of Boone Lake to an elevation of 412 m (1,352')—3.1 m (10') below winter pool. TVA maintains a water quality monitoring station in the tailwater near the dam that currently records several parameters at 3-min. intervals. There were no issues with elevated water temperatures during 2015-2017 (Habera et al. 2016, 2017, 2018a). Water temperature reached 21°C on eight days during late July through mid-August 2018, but reached the 22-23°C range only briefly (≤1 h) on two of those days. The Boone tailwater reach of the South Fork Holston River is listed under TDEC's water usage classifications (Chapter 0400-40-04; TDEC 2013) and water quality standards (Chapter 0400-40-03; TDEC 2015) as trout water with a minimum dissolved oxygen (DO) criterion of 6 mg/l. There were no DO issues in 2015 (Habera et al. 2016), although DO levels in the 4.0-6.0 mg/l range routinely occurred during May-July and October 2016, occasionally during July-October 2017, and on 26 days during July-August of 2018. Currently, there do not appear to be any effects on the tailwater trout fishery related to these summer and early fall water temperature and DO conditions. TVA projects that repairs to the dam will be completed in 2022.

Management Recommendations

The Boone tailwater supports a relatively small trout fishery, but one that consistently—like the Ft. Patrick Henry tailwater downstream—produces large, well-conditioned trout. Consequently, a management plan for the Boone and Ft. Patrick Henry tailwaters for 2019-2024 has been developed (Habera et al. 2018b). The management goal for the Boone tailwater is to fully develop and maintain its potential—particularly for producing the large, well-conditioned Rainbow Trout—thus providing exceptional angling opportunities. TWRA will continue to use put-and-grow and put-and-take Rainbow Trout, Brown Trout, and Brook Trout fisheries to attain the management goal. The plan addresses Hatchery-Supported Fisheries Goal 1 (Optimize Use of Hatchery Trout), Strategy 5 in TWRA's current Statewide Trout Management Plan (TWRA 2017).

Management plan objectives are to:

1. *Identify and consistently apply optimal trout stocking rates*
2. *Maintain a mean RSD-18 of ≥20 for all trout and ≥10 for Rainbow Trout*
3. *Maintain a mean W_r >100 for trout*
4. *Ensure that the trout fishery is not impacted by the Boone Reservoir drawdown, and*
5. *Educate anglers on potential biosecurity threats to the trout fishery*

The four monitoring stations will be sampled annually to obtain information necessary for evaluating management plan Objectives 1-3. Fingerling Rainbow Trout stocked in 2019 will be marked (by fin clips or coded-wire implants) to help evaluate Objective 1. This fishery is currently subject to statewide trout angling regulations and no changes are recommended at this time.

Boone Tailwater

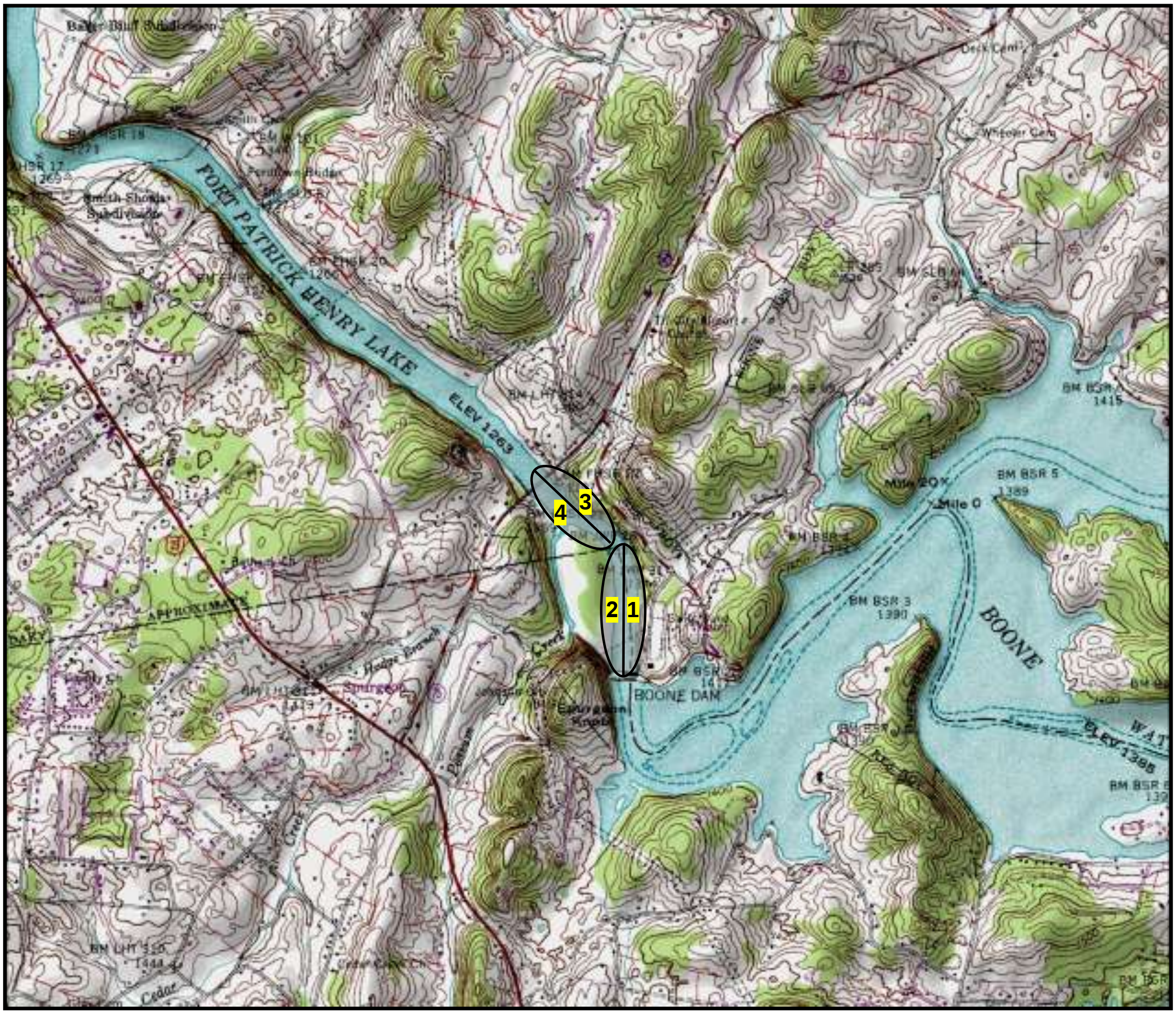


Figure 3-30. Location of the Boone tailwater (South Fork Holston River) monitoring stations.

Table 3-10 Location and sampling information for the four stations on the Boone tailwater, 7 March 2018.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420180101	Sullivan	Boone Dam 198 NW	36.44302N-82.43746W	06010102-5,1	18.5	900	200 V DC 120 PPS, 4 A
2	420180102	Washington	Boone Dam 198 NW	36.44344N-82.43823W	06010102-5,1	18.5	900	884 V DC 120 PPS, 5 A
3	420180103	Sullivan	Boone Dam 198 NW	36.44589N-82.43883W	06010102-5,1	18.2	900	200 V DC 120 PPS, 4 A
4	420170404	Sullivan	Boone Dam 198 NW	36.44589N-82.43887W	06010102-5,1	18.2	900	884 V DC 120 PPS, 5 A

Table 3-11. Catch data for the four electrofishing stations on the Boone tailwater sampled 7 March 2018.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	5	222-262	627	15	6
	Brown	13	195-530	5,979	38	60
	Brook	16	224-320	3,378	47	34
Totals		**34**		**9,984**	**100**	**100**
2	Rainbow	15	214-582	4,414	48	62
	Brown	4	180-212	347	13	5
	Brook	12	233-325	2,354	39	33
Totals		**31**		**7,115**	**100**	**100**
3	Rainbow	8	236-470	5,068	47	71
	Brown	2	193-195	161	12	2
	Brook	7	273-319	1,928	41	27
Totals		**17**		**7,157**	**100**	**100**
4	Rainbow	13	223-398	4,898	46	57
	Brown	2	217-355	667	7	8
	Brook	13	240-303	3,005	46	35
Totals		**28**		**8,570**	**100**	**100**
Total Rainbow Trout		**41**	214-582	**15,007**	37	46
Total Brown Trout		**21**	180-530	**7,154**	19	22
Total Brook Trout		**48**	224-325	**10,665**	44	32
Overall totals		**110**		**32,826**	**100**	**100**

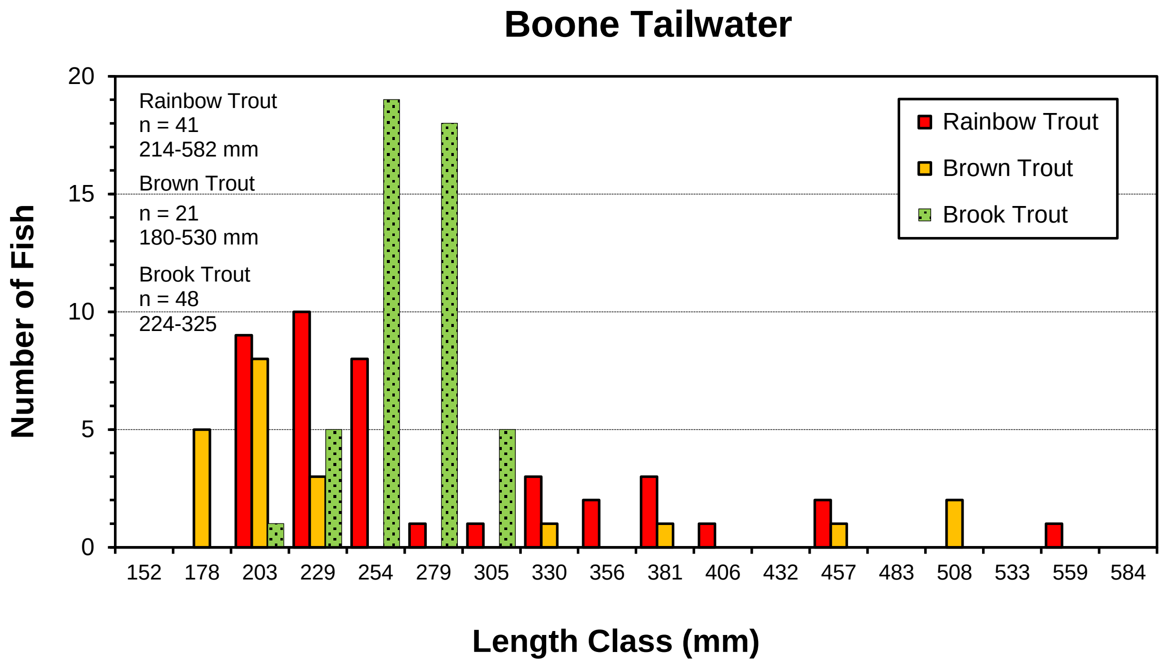


Figure 3-31. Length frequency distributions for trout from the Boone tailwater monitoring stations in 2018.

Boone Tailwater

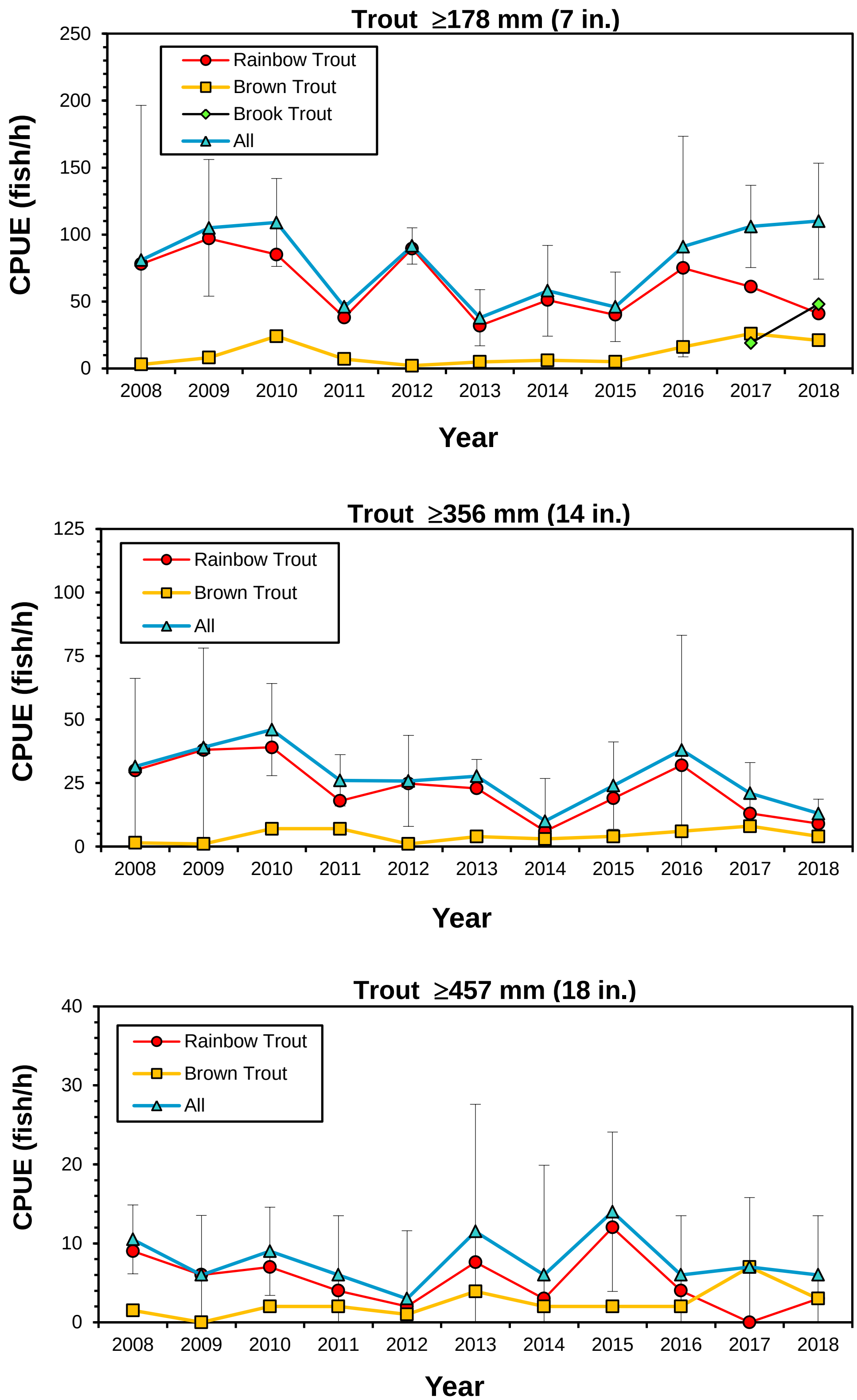


Figure 3-32. Mean trout CPUEs for the Boone tailwater samples. Bars indicate 90% confidence intervals.

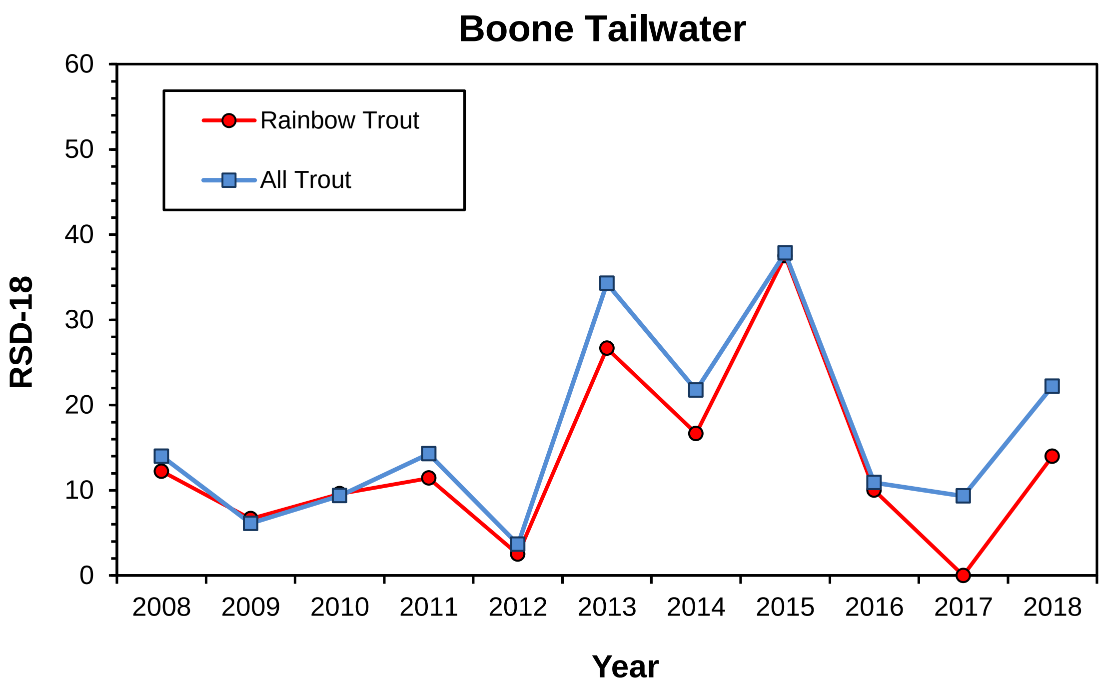


Figure 3-33. RSD-18 for Boone tailwater trout (2008-2018).

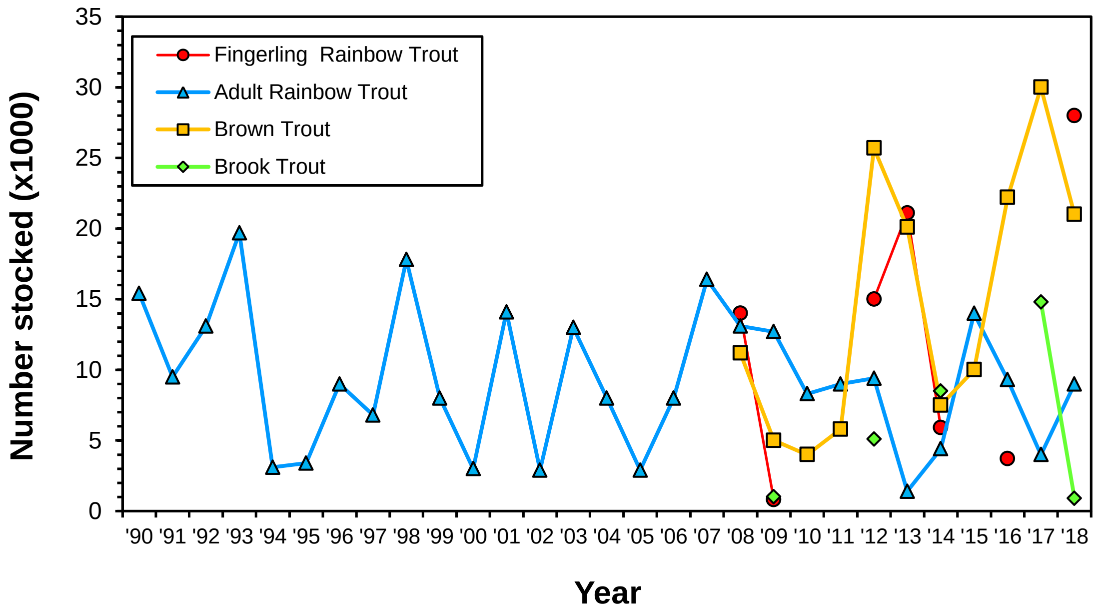


Figure 3-34. Recent trout stocking rates for Ft. Patrick Henry Lake / Boone tailwater. An average of 6,600 adult Rainbow Trout, 6,100 fingerling Rainbow Trout, 18,000 Brown Trout, and 4,700 Brook Trout was stocked during 2014-2018.

3.2.6 South Holston (South Fork Holston River)

Study Area

The South Holston tailwater extends ~22.5 km (13.7 mi.) from South Holston Dam to Boone Reservoir. The tailwater was created in 1951 when TVA completed construction of the dam at South Fork Holston River Mile (SFHRM) 49.8 in Sullivan County, Tennessee. The reservoir upstream of the dam has a drainage area of 1,821 km^2 and extends upstream for 38.1 km into Washington County, Virginia. Much of the watershed is forested and includes portions of the CNF (Tennessee) and the Jefferson National Forest (Virginia). The tailwater has an average width of 61 m and a surface area of about 137 ha.

TVA addressed low DO levels during summer and fall and a lack of minimum flow in the tailwater by constructing an aerating labyrinth weir at SFHRM 48.5 in 1991 as part of its Reservoir Releases Improvement Program. The weir maintains a minimum flow of 2.55 m^2/s (90 CFS) and recovers approximately 40-50% of the oxygen deficit as water passes over it (Yeager et al. 1993). The turbine is typically pulsed twice daily to maintain the weir pool and these releases are aerated via turbine venting aided with hub baffles. The weir and turbine improvements combine to help maintain the target DO concentration of 6 ppm.

TVA's labyrinth weir on the South Holston tailwater.

The first trout stockings in the South Holston tailwater occurred in 1952 and included fingerling and adult Rainbow Trout and Brook Trout. Subsequently, annual stockings of adult and fingerling Rainbow Trout, as well as sub-adult Brown Trout maintained put-and-take and put-and-grow fisheries. Investigations conducted for TWRA by Bettoli et al. (1999) documented substantial natural reproduction (particularly by Brown Trout) and an overwintering biomass (80% Brown Trout) of 170-232 kg/ha. Later, Meerbeek and Bettoli (2005) measured an overwintering Brown Trout biomass of 207 kg/ha during 2003-2004 (highest among all Tennessee tailwaters). Mork's (2011) study of large (>460 mm) Brown Trout movement in the Boone Lake system verified that some South Holston fish use the reservoir in winter and spring (but not fish from the Wilbur tailwater) and that there was no intermingling of fish from those two populations. No Brown Trout have been stocked in the South Holston tailwater since 2003 because of the abundant wild Brown Trout fishery that has developed. Rainbow Trout continue to be managed as both a put-and-take and put-and-grow fishery by stocking 40,000 adults and 50,000 fingerlings annually (Habera et al. 2015c).

Management strategy for the South Holston tailwater shifted to a focus on the wild Brown Trout fishery with better biological information and corresponding angler support. All snagging was banned in 1999 and two major trout spawning areas were closed to fishing during November-January. These measures were taken to protect large Brown Trout during the spawning season and to facilitate development of a self-sustaining fishery. A 406-559 mm (16-22 in.) protected length range (PLR) or “slot limit” was established for the entire tailwater in 2000 with the goal of shifting population structure toward larger fish and protecting spawners (primarily Brown Trout). Slot limits of this type have been shown to be effective at improving trout population size structures (Luecke et al. 1994; Power and Power 1996).

TWRA established two monitoring sites on the South Holston tailwater in 1995 (Bivens et al. 1996) and sampled these annually during the summer (at base flow) to begin compiling a database on the existing trout fishery. These sites were replaced in 1999 with the 12 stations (Figure 3-35) and protocol established by Bettoli et al. (1999). Current sample site location and effort details are summarized in Table 3-12.

Results and Discussion

The 12 South Holston tailwater monitoring stations produced 530 trout weighing 123 kg in 2018 (Table 3-13). Brown Trout catch declined again in 2018—8% relative to 2017 and 39% since 2014, while corresponding biomass decreases were 24% and 45%. Brown Trout represented 89% of the sample by number and 87% by biomass in 2018, which is similar to samples from recent years. Brown Trout relative abundance first exceeded 80% in 2007 and has averaged 86% since then.

A large Brown Trout from the South Holston tailwater.

The abundant sub-adult (≤127 mm) Brown Trout captured in 2017 (Habera et al. 2018a) recruited well as indicated by catch increases in the 178- (130%), 208- (250%), and 229-mm (76%) size classes (Figure 3-36). However, the abundance of Brown Trout in the 279-356 mm size classes in 2017 (Habera et al. 2018a) did not recruit well into the larger size classes in 2018, as the number of fish in the 305-

to 381-mm size classes all declined by 27-46% (Figure 3-36). Brown Trout in 2018 exhibited the typical bimodal length frequency distribution, with modes at the 178- and 330-mm classes (Figure 3-36). Brown Trout in the 229-330 mm (9-13 in.) size classes averaged of 69% of the catch during 2011-2015, but decreased to 59% in 2016 and 2017 (Habera et al. 2018a) and then to 46% in 2018 (Figure 3-36). There was a slight improvement in the catch of Brown Trout in the PLR relative to 2017 (15 to 17), although the average PLR catch for 2010-2018 (19 fish) is less than half the 2004-2009 average (44).

Relative stock density for Brown Trout ≥406 mm (RSD-16) —based on a stock size of 254 mm (Willis et al. 1993)—improved to 7 in 2018, which is the highest level since 2009 (10; Figure 3-37). Prior to any influence from the PLR regulations (1997, 1999-2000) Brown Trout RSD-16 averaged 26 with a corresponding mean CPUE (all trout) of 105 fish/h (≥178 mm). Following establishment of the PLR, Brown Trout RSD-16 reached 21-23 during 2005-2007 but has declined since then (Figure 3-37) as total CPUE (≥178 mm) increased into the 300-400 fish/h range. Consequently Brown Trout population size structures did not maintain the initial shift toward larger fish—one of the original intents of the PRL. Rainbow Trout ≥406 mm are uncommon in the South Holston tailwater and corresponding RSD-16 has averaged 3. The Norris tailwater PLR (356-508 mm or 14-20 in.), by comparison, has successfully altered trout population size structures in favor of larger fish and maintained that shift (see Section 3.2.1).

When overall trout abundance in the South Holston tailwater is relatively high (CPUE >200 fish/h) and the angler harvest rate for Brown Trout is low (3-5% during 2014-17), it is unlikely that RSD-16 will improve much. In fact, current trout abundance would require doubling the 2017 catch for trout ≥406 mm or 16 in. from 20 to 42 to raise RSD-16 to 10, which would still be below the pre-PLR mean of 15. Although RSD target values have not been defined for balanced Brown Trout populations (Pedicillo et al. 2010), RSD-16 for South Holston tailwater Brown Trout has reached the 15-20 range both before and after (2005-2007) establishment of the PLR regulation. Achieving and maintaining an RSD-16 of ~15 (mostly composed of Brown Trout) would more closely align with the basic management goal of providing a high-quality trout fishery (Habera et al. 2015c).

Brown Trout RSD-16 in the South Holston tailwater may further improve if mean CPUE for trout ≥178 mm (total) continues to decline toward the 150-200 fish/h range considered in the management plan (Habera et al. 2015c) to be more conducive to recruitment into the PLR. The 2018 mean catch rate for trout ≥178 mm (242 fish/h) declined for the fourth consecutive year (Figure 3-38) and, as mentioned above, was accompanied by the highest Brown Trout RSD-16 in nine years. The mean catch rate for Rainbow Trout ≥178 mm was 29 fish/h in 2018 (Figure 3-38) and 31 fish/h for the past three years, which is below the current management plan objective of ≥50 fish/h (Habera et al. 2015c). Trout ≥356 mm are considered to be "quality-sized" fish and the mean catch rate for these fish peaked at 72 fish/h in 2005; however, it has generally declined since then and was 30 fish/h in 2018 (Figure 3-38). The catch rate for trout in the PLR (406-559 mm) has also declined from its peak of 29 fish/h in 2006 and now appears to be stabilizing at about 9-10 fish/h—which is similar to the pre-PLR range (Figure 3-38).

The substantial (nearly 3-fold) increase in trout abundance since the late 1990s (primarily wild Brown Trout) appears to have affected growth (Bohlin et al. 2002; Vøllestad et al. 2002; Lobon-Cervia 2007) and recruitment (Walters and Post 1993)—particularly to larger size classes. Food resources tend to limit salmonid populations in tailwaters and unregulated streams (e.g., Filbert and Hawkins 1995; Ensign et al. 1990; Korman et al. 2017) and competition for those resources increases as fish numbers increase. Mean relative weights (W_r) for Brown Trout in the size classes immediately below the PLR (305-405 mm) were typically >90 prior to 2007, but there has been a general decline as overall abundance increased (Figure 3-39). Mean W_r for Brown Trout in the PLR has also generally declined since 2005, although there was a slight improvement in 2018 (to 88; Figure 3-39). This suggests that the abundance of trout in the tailwater has affected condition and thereby limited growth and recruitment into the PLR. Korman et al. (2017) related poor condition of larger Rainbow Trout in the Glen Canyon tailwater (AZ) to low fall/winter survival rates. Yard et al. (2015) observed that the highest growth and relative condition for Rainbow Trout in Glen Canyon tailwater (AZ) occurred in areas with lower densities. Similarly, McKinney et al. (2001) reported that increased abundance of Rainbow Trout in the Lee's Ferry tailwater, AZ (resulting from higher, more stable flows) was accompanied by reduced relative condition, particularly for fish ≥305 mm. Dibble et al. (2015) also found that Brown Trout length declined when large cohorts recruited to adult size in western tailwaters. Additionally, Fox and Neal (2011) saw depressed largemouth bass *Micropterus salmoides* W_r at intermediate sizes as the population—managed with a 356-508 mm PLR—became overcrowded. Warmer water temperatures (approaching 21° C) can be a concern in the lower portion of the South Holston tailwater in some years (e.g., 2014; Habera et al. 2015a) and such conditions can inhibit growth, particularly at lower levels of prey availability (Dodrill et al. 2016; Dibble et al. 2018).

Typical electrofishing catch from a South Holston tailwater monitoring station.

Density-dependent factors continue to limit Brown Trout growth, condition, and recruitment into the larger size classes (i.e., the PLR). Dreves et al. (2016) used a 508-mm (20-in.) minimum size limit and 1 fish/day creel limit to improve the size structure of Brown Trout (particularly for fish ≥381 mm) in the Lake Cumberland tailwater (KY) without incurring density-dependent impacts to growth and condition. Although Brown Trout CPUE there increased 3-fold over 10 years, it remained relatively low overall (89 fish/h) and most likely below the carrying capacity of the tailwater (Dreves et al. 2016); density-dependent responses, therefore, were not triggered.

Additionally, the Cumberland Lake tailwater Brown Trout fishery is hatchery supported, thus providing essentially stable recruitment. Ultimately, if food availability and fish growth are limited in tailwater trout fisheries (e.g., in high abundance populations), then restrictive angling regulations may be unsuccessful (Flinders and Magoulick 2017).

Factors that impact trout year-class strength, such as high flows, can reduce density-dependent effects on growth, condition, and recruitment. Any such events in the South Holston tailwater have had minimal effects on Brown Trout year-class strength, as cohorts produced during the past several years have been sufficient to substantially increase abundance—even with declining numbers of large spawners. Brown Trout spawning activity in the South Holston tailwater begins during early November and peaks in mid to late-December (Banks and Bettoli 2000). A somewhat earlier spawning season (mid-October through November) was observed for Brown Trout in the White River (AR) tailwater, with emergence there beginning at the end of February (Pender and Kwak 2002). Fry emergence in the South Holston tailwater has not been studied, but likely occurs in March or early April (based on spawning period). Dibble et al. (2015) observed that Brown Trout recruitment was affected most by flow velocity, and that high levels of recruitment indirectly reduce fish size. Therefore, management actions that can decrease Brown Trout recruitment when necessary, such as altering dam operations (i.e., to produce high flows) could help maintain more stable trout populations with larger adults through relaxed intraspecific competition (Dibble et al. 2015) and avoidance of boom-and-bust cycles (Korman et al. 2017). Pender and Kwak (2002) observed age-0 tailwater Brown Trout using gravel interstices as refugia from high velocities at the onset of water releases, so velocities would have to be high enough or the fish vulnerable enough for high flows to be effective. This timeframe would likely occur just after emergence (March-April) in the South Holston tailwater, although it coincides with the refill period on TVA's guide curve for South Holston Lake. Interestingly, extended marginally-high flows (20-50% above average) improved development of large cohorts or Rainbow Trout in the Glen Canyon tailwater (Avery et al. 2015).

Roving creel surveys conducted on the South Holston tailwater by TWRA in 2014 (Black 2015) and 2017 (Black 2018) indicated that pressure and trips decreased substantially over the three-year period (35% and 32%, respectively), while catch declined 48% and harvest fell 26% (see table below). The average trout catch rate (fish/h) also decreased 20% between 2014 (2.16 fish/h) and 2017 (1.72 fish/h), but both catch rates were well above the 0.7 fish/h level generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). Mean trip length remained relatively consistent between the two surveys (5.43 h vs. 5.25 h), but average catch per trip decreased by nearly 3 fish because of the reduced catch. The overall trout harvest rate increased from 9% in 2014 to 13% in 2017 (Figure 3-8) and is similar to the most recent trout harvest rates for the Wilbur (10%; Black 2017) and Norris (13%; Black 2018) tailwaters. The average number of trout harvested per trip by South Holston tailwater anglers remained near 1 fish/trip in 2014 (1.04) and 2017 (1.14). Rainbow Trout represented the majority of catch (52-64%) and harvest (81-86%) during the previous three creel surveys.

Year	Pressure (h)	Mean Trip length (h)	Trips	Catch[a]	Harvest[a]
2014	131,842	5.43	24,285	285,013 (52)	25,293 (81)
2017	86,082	5.25	16,405	147,641 (64)	18,718 (86)

[a]Values in parentheses are percentages represented by Rainbow Trout.

Brown Trout catch rates ranged from 53,000-137,000 during the 2014 and 2017 surveys (Black 2015, 2018; see table below). These catches appear high enough that harvest could help reduce population size and improve growth, condition, and recruitment into the PLR; however, Brown Trout harvest rates are low (about 3-5%). Consequently, anglers have been encouraged to harvest 229-305 mm (9-12 inch) Brown Trout. When asked during the 2017 survey, more anglers said they would increase their harvest of smaller (9-12 inch) Brown Trout than those who said they would not (44% vs. 40%) given that it would help improve population size structure. The new angler survey underway on the South Holston tailwater in 2019 should help determine to what extent anglers follow through and harvest more Brown Trout (results will be available in 2020).

Year	Brown Trout			Rainbow Trout		
	Catch	Harvest	Harvest Rate (%)	Catch	Harvest	Harvest Rate (%)
2014	136,853	4,858	3.5	148,080	20,435	13.8
2017	53,416	2,627	4.9	93,786	15,999	17.1

Harvesting fish below the lower boundary of a PLR is necessary to prevent overcrowding; without sufficient exploitation, stockpiling occurs and the regulation becomes ineffective (Wilde 1997; Noble and Jones 1999; Fox and Neal 2011). However, if anglers are generally satisfied with the increased Brown Trout abundance and relatively high catch rates that exist now, then they may not be concerned by the current ineffectiveness of the PLR.

The parasite that causes whirling disease (*Myxobolus cerebralis*) was confirmed in Rainbow Trout from the South Holston tailwater by the U.S. Fish and Wildlife Service's Fish Health Lab in Warm Springs, GA in 2017. The Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University, which conducted all *Myxobolus* screening for TWRA in 2018, requested that the South Holston tailwater be resampled so that the initial positive results could be confirmed (with Rainbow Trout fingerlings. Consequently, 60 Rainbow Trout ≤100 mm were collected at three sites throughout the tailwater on 16 July. Because no fingerling Rainbow Trout had been stocked at that point in 2018, those fish must have been the result of natural reproduction—which may be more substantial than previously understood. The screening results were positive for the 2018 sample and TWRA will continue to move forward with information and education efforts directed at preventing the spread of spores and infected fish.

Management Recommendations

The South Holston's exceptional wild Brown Trout fishery is the primary means for attaining the tailwater's management goal of providing a high-quality trout fishery and the associated variety of angling opportunities it offers (Habera et al. 2015c). The Brown Trout fishery helps produce the high angler catch rates and satisfaction levels mentioned above. Even with the expansion of Brown Trout abundance, Rainbow Trout remain an important part of the fishery—particularly in terms of angler harvest. Rainbow Trout are sustained through consistent annual stocking of adults and fingerlings. However, the presence of substantial numbers of wild age-0 Rainbow Trout in 2018 suggests that it would be useful to re-examine the effectiveness of stocked fingerlings (e.g., by marking a cohort or suspending stocking for a one or two years). Currently, no other management changes are recommended for this tailwater

South Holston Tailwater

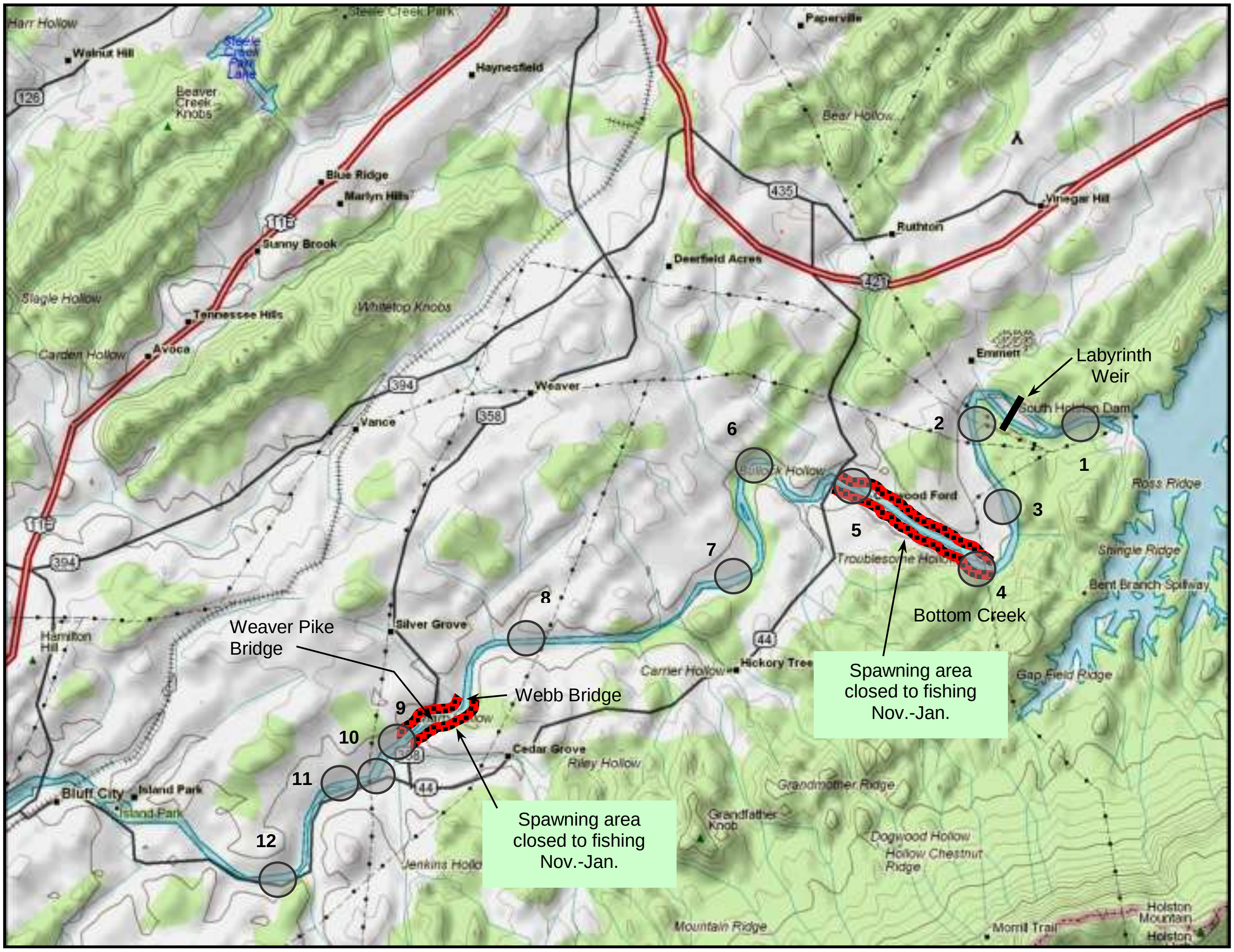


Figure 3-35. Locations of the South Holston tailwater (South Fork Holston River) monitoring stations.

Table 3-12. Location and sampling information for the 12 stations on the South Holston tailwater, 14 March 2018.

Station	Site Code	County	Quadrangle	Coordinates	Reach Number	River Mile	Effort (s)	Output
1	420180301	Sullivan	Holston Valley 206 SE	36.5236N-82.09306W	06010102-14,0	49.5	600	884 V DC 120 PPS, 4-5 A
2	420180302	Sullivan	Holston Valley 206 SE	36.52500N-82.11528W	06010102-14,0	48	600	884 V DC 120 PPS, 4-5 A
3	420180303	Sullivan	Holston Valley 206 SE	36.50972N-82.10694W	06010102-14,0	46.8	600	884 V DC 120 PPS, 4-5 A
4	420180304	Sullivan	Holston Valley 206 SE	36.50417N-82.11111W	06010102-13,2	46.4	600	884 V DC 120 PPS, 4-5 A
5	420180305	Sullivan	Bristol 206 SW	36.51250N-82.12778W	06010102-13,2	45.3	600	884 V DC 120 PPS, 4-5 A
6	420180306	Sullivan	Bristol 206 SW	36.51389N-82.14444W	06010102-13,2	44.2	600	884 V DC 120 PPS, 4-5 A
7	420180307	Sullivan	Bristol 206 SW	36.50972N-82.14861W	06010102-13,2	43	600	30-40% low range 120 PPS DC, 4 A
8	420180308	Sullivan	Bristol 206 SW	36.49528N-82.18056W	06010102-13,2	40.6	600	30-40% low range 120 PPS DC, 4 A
9	420180309	Sullivan	Keenburg 207 NW	36.48194N-82.20556W	06010102-13,2	38.6	600	30-40% low range 120 PPS DC, 4 A
10	420180310	Sullivan	Keenburg 207 NW	36.47917N-82.20833W	06010102-13,2	38.4	600	30-40% low range 120 PPS DC, 4 A
11	420180311	Sullivan	Keenburg 207 NW	36.47778N-82.21528W	06010102-13,1	38	600	30-40% low range 120 PPS DC, 4 A
12	420180312	Sullivan	Keenburg 207 NW	36.46556N-82.22083W	06010102-13,1	37.1	600	30-40% low range 120 PPS DC, 4 A

Table 3-13. Catch data for the12 electrofishing stations on the South Holston tailwater sampled 14 March 2018.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	12	262-550	6,482	92	96
	Brown	1	292	269	5	5
Totals		**13**		**6,751**	**97**	**101**
2	Rainbow	4	285-336	1,277	5	8
	Brown	76	142-531	15,403	95	92
Totals		**80**		**16,680**	**100**	**100**
3	Rainbow	1	265	179	1	2
	Brown	74	132-414	9,662	99	98
Totals		**75**		**9,841**	**100**	**100**
4	Rainbow	4	339-386	1,561	6	10
	Brown	61	143-436	13,334	94	90
Totals		**65**		**14,895**	**100**	**100**
5	Rainbow	7	193-320	1,292	14	11
	Brown	43	172-391	10,785	86	89
Totals		**50**		**12,077**	**100**	**100**
6	Rainbow	1	239	142	2	1
	Brown	52	164-420	11,540	98	99
Totals		**53**		**11,682**	**100**	**100**
7	Rainbow	9	196-362	1,552	16	15
	Brown	48	159-382	9,067	84	85
Totals		**57**		**10,619**	**100**	**100**
8	Rainbow	4	240-324	756	13	9
	Brown	27	150-479	7,443	87	91
Totals		**31**		**8,199**	**100**	**100**
9	Rainbow	3	214-247	381	9	5
	Brown	29	186-503	6,999	91	95
Totals		**32**		**7,380**	**100**	**100**
10	Rainbow	0	--	0	0	0
	Brown	21	152-485	5,173	100	100
Totals		**21**		**5,173**	**100**	**100**
11	Rainbow	10	214-351	1,904	30	13
	Brown	23	203-609	12,457	70	87
Totals		**33**		**14,361**	**100**	**100**
12	Rainbow	3	265-348	885	15	17
	Brown	17	150-412	4,349	85	83
Totals		**20**		**5,234**	**100**	**100**
Total Rainbows		58	193-550	16,411	11	13
Total Browns		472	132-609	106,481	89	87
Overall totals		**530**		**122,892**	**100**	**100**

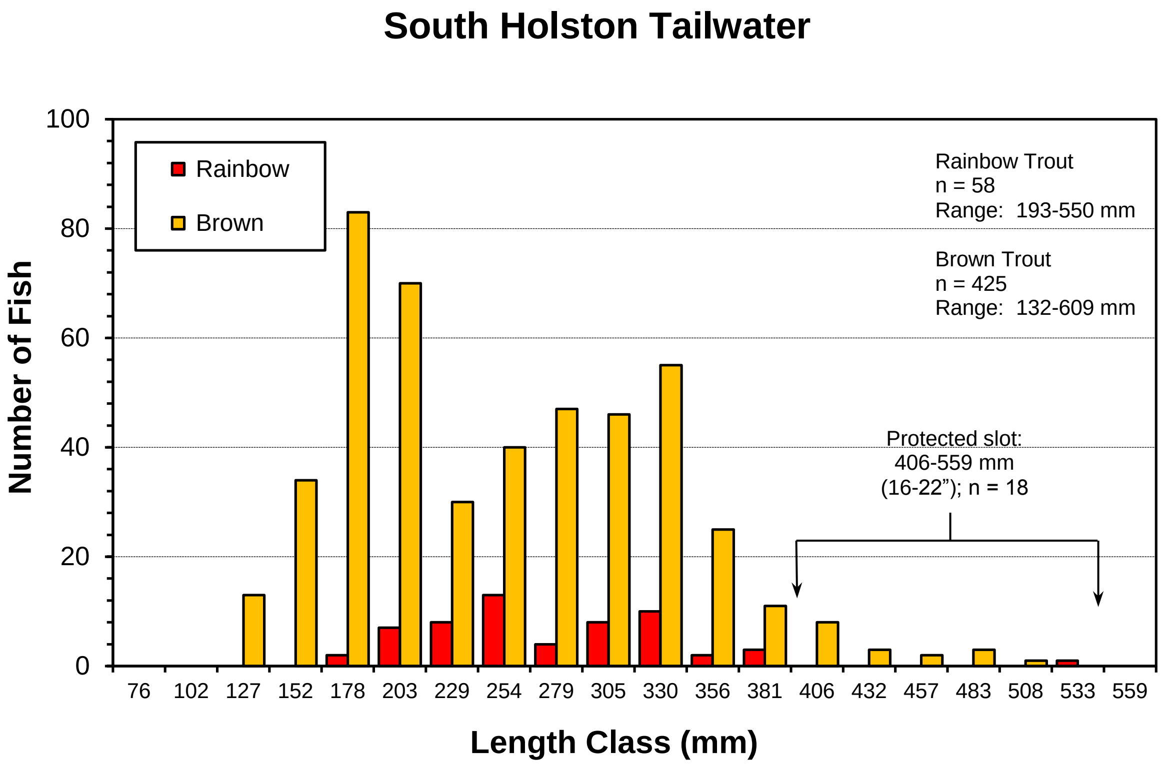


Figure 3-36. Length frequency distributions for trout from the South Holston tailwater monitoring stations in 2018.

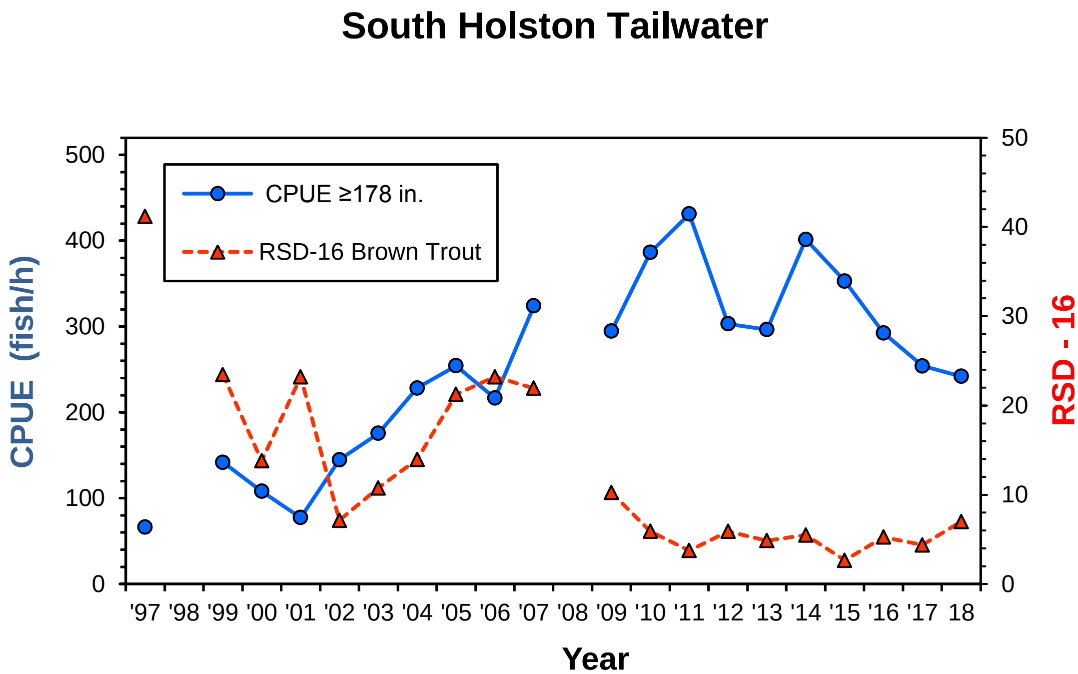


Figure 3-37. Comparison of mean CPUE (fish/h) for all trout ≥178 mm and RSD-16 (all trout) for the South Holston tailwater.

South Holston Tailwater

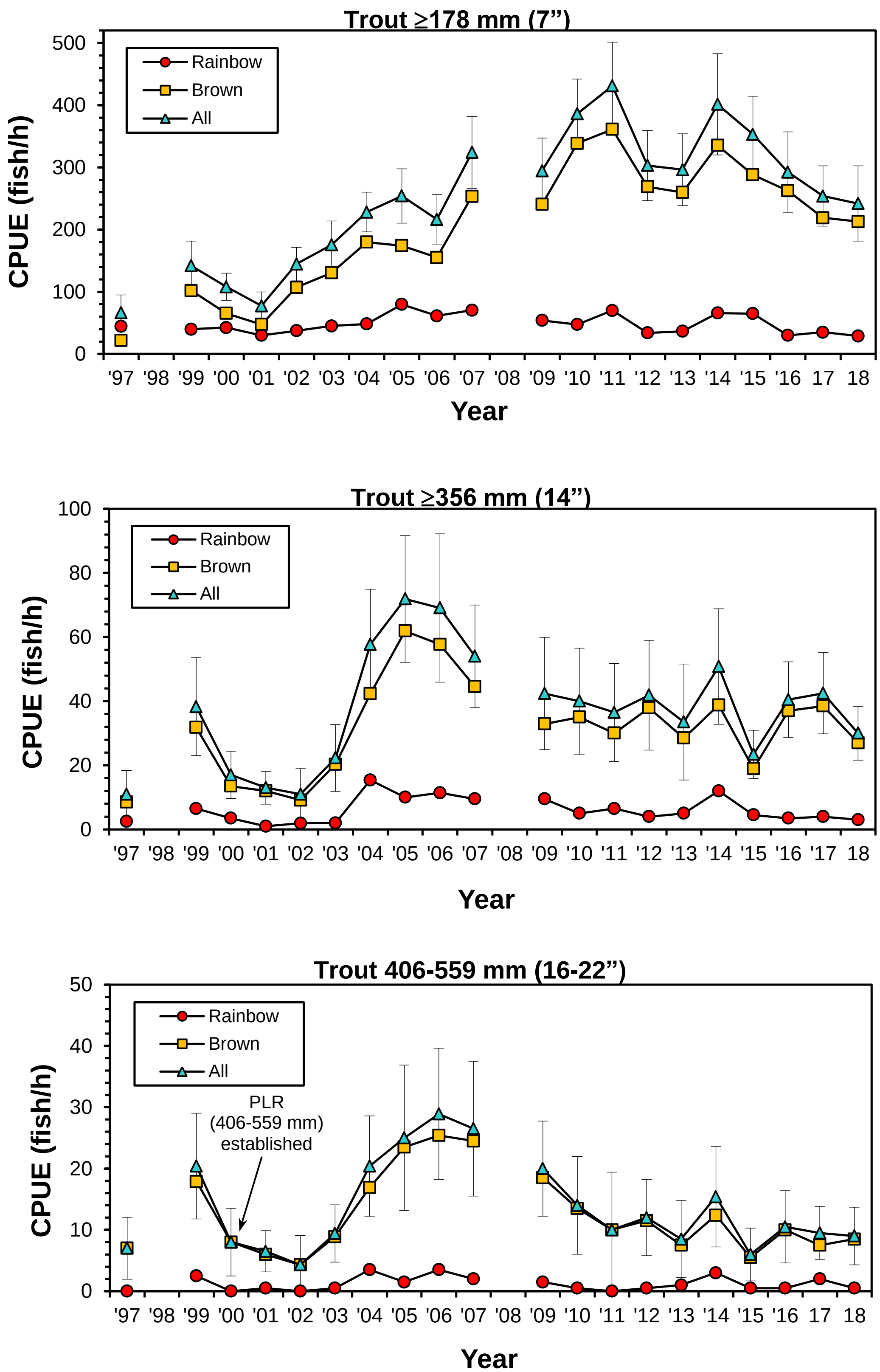


Figure 3-38. Mean trout CPUEs for the South Holston tailwater samples.
Bars indicate 90% confidence intervals.

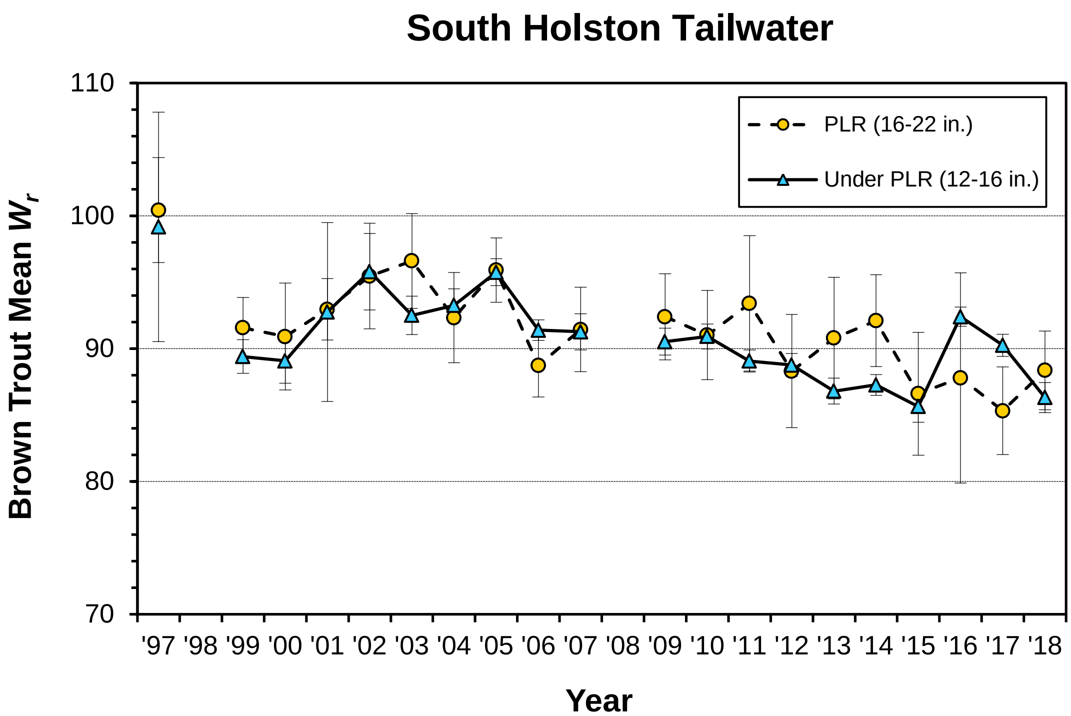


Figure 3-39. Mean relative weights (W_r) for brown trout from the South Holston tailwater. Bars indicate 90% confidence intervals.

REFERENCES

Adams, S. B., C. A. Frissell, and B. E. Rieman. 2002. Changes in distribution of nonnative brook trout in an Idaho drainage over two decades. Transactions of the American Fisheries Society 131:561-568.

Anderson, R. O. 1976. Management of small warm water impoundments. Fisheries 1(6):561-568.

Anglin, Z. W., and G. D. Grossman. 2013. Microhabitat use by southern brook trout (Salvelinus fontinalis) in a headwater North Carolina stream. Ecology of Freshwater Fish 22:567-577.

Avery, L. A., J. Korman, and W. R. Persons. 2015. Effects of increased discharge on spawning and age-0 recruitment of Rainbow Trout in the Colorado River at Lees Ferry, Arizona. North American Journal of Fisheries Management 35:671-680.

Baird, O. E., and C. C. Krueger. 2003. Behavioral thermoregulation of brook and Rainbow Trout: comparison of summer habitat use in an Adirondack river, New York. Transactions of the American Fisheries Society 132:1194-1206.

Banks, S. M., and P. W. Bettoli. 2000. Reproductive potential of Brown Trout in Tennessee tailwaters. Fisheries Report No. 00-19. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettinger, J. M., and P. W. Bettoli. 2000. Movements and activity of Rainbow Trout and Brown Trout in the Clinch River, Tennessee, as determined by radio-telemetry. Fisheries Report No. 00-14. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 1999. Creel survey and population dynamics of salmonids stocked into the Watauga River below Wilbur Dam. Fisheries Report No. 99-41. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2002. Clinch River creel survey results: March-October 2001. Fisheries Report No. 02-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2003a. Survey of the trout fishery in the Watauga River: March-October 2002. Fisheries Report No. 03-05. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2003b. Survey of the trout fishery in the South Fork of the Holston River, March-October 2002. Fisheries Report No. 03-06. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2006. Clinch River creel survey results: April-October 2005. Fisheries Report No. 06-08. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2007. Surveys of the trout fisheries in the Watauga River and South Fork of the Holston River: March-October 2005. Fisheries Report No. 07-07. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W., and L. A. Bohm. 1997. Clinch River trout investigations and creel survey. Fisheries Report No. 97-39. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W., S. J. Owens, and M. Nemeth. 1999. Trout habitat, reproduction, survival, and growth in the South Fork of the Holston River. Fisheries Report No. 99-3. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D. 1979. Survey of brook trout streams on the Unaka and Nolichucky Ranger Districts, Cherokee National Forest. Internal project report, U.S. Department of Agriculture Forest Service, Cleveland, Tennessee.

Bivens, R. D. 1984. History and distribution of brook trout in the Appalachian region of Tennessee. MS thesis, University of Tennessee, Knoxville, Tennessee.

Bivens, R. D. 1988. Region IV stream fishery data collection report: 1986-1987. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D. 1989. Region IV stream fishery data collection report: 1988. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., R. J. Strange, and D. C. Peterson. 1985. Current distribution of the native brook trout in the Appalachian region of Tennessee. Journal of the Tennessee Academy of Science 60:101-105.

Bivens, R. D., and C. E. Williams. 1990. Region IV stream fishery data collection report: 1989. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., M. T. Fagg, and C. E. Williams. 1992. Region IV trout fishery data collection report: 1991. Fisheries Report No. 93-17. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1996. Region IV trout fisheries report: 1995. Fisheries Report No. 96-5. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1997. Region IV trout fisheries report: 1996. Fisheries Report No. 97-2. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bivens, R. D., B. D. Carter, and C. E. Williams. 1998. Region IV trout fisheries report: 1997. Fisheries Report 98-3. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2014. Tennessee Statewide Creel Survey: 2013 Results. Final report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2015. Tennessee Statewide Creel Survey: 2014 Results. Final report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2017. Tennessee Statewide Creel Survey: 2016 Results. Fisheries Report 17-07. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2018. Tennessee Statewide Creel Survey: 2017 Results. Fisheries Report 18-06. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bohlin, T., L. F. Sundström, J. I. Johnsson, J. Höjesjö, and J. Pettersson. 2002. Density-dependent growth in Brown Trout: effects of introducing wild and hatchery fish. Journal of Animal Ecology 71:683-692.

Boles, H. D. 1980. Clinch River (Norris tailwater) trout fishery investigations 1971-1977. Fisheries Resources Internal Report (Interim Summary Report). U. S. Department of Interior, Fish and Wildlife Service.

Bowlby, J. N., and J. C. Roff. 1986. Trout biomass and habitat relationships in southern Ontario streams. Transactions of the American Fisheries Society 115:503-514.

Carline, R. F., and B. J. McCullough. 2003. Effects of floods on brook trout populations in the Monongahela National Forest, West Virginia. Transactions of the American Fisheries Society 132:1014-1020.

Clark, M. E., and K. A. Rose. 1997. Factors affecting competitive dominance of Rainbow Trout over brook trout in southern Appalachian streams: implications of an individual-based model. Transactions of the American Fisheries Society 126:1-20.

Clark, M. E., K. A. Rose, D. A. Levine, and W. W. Hargrove. 2001. Predicting climate change effects on Appalachian trout: combining GIS and individual-based modeling. Ecological Applications 11(1):161-178.

Cook, S. B. and T. C. Johnson. 2016. Assessment of southern Appalachian brook trout propagation as a tool for restoring Tennessee populations. Final report, Department of Biology and the Center for the Management, Protection and Utilization of Water Resources, Tennessee Technological University, Cookeville, Tennessee.

Damer, J., and P. W. Bettoli. 2008. The fate of brook trout stocked in the Watauga River below Wilbur Dam. Fisheries Report No. 08-03. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Davis, L., and T. Wagner. 2016. Scale-dependent seasonal pool habitat use by sympatric wild brook trout and Brown Trout populations. Transactions of the American Fisheries Society 145:888-902.

DeWeber, J. T., and T. Wagner. 2015. Predicting brook trout occurrence in stream reaches throughout their native range in the eastern United States. Transactions of the American Fisheries Society 144:11-24.

Dibble, K. L., C. B. Yackulic, T. A. Kennedy, and P. Budy. 2015. Flow management and fish density regulate salmonid recruitment and adult size in tailwaters across western North America. Ecological Applications 25:2168-2179.

Dibble, K. L., C. B. Yackulic, and T. A. Kennedy. 2018. Warm water temperatures and shifts in seasonality increase trout recruitment but only moderately decrease adult size in western North American tailwaters. Environmental Biology of Fishes 101:2169-2183.

Dodrill, M. J., C. B. Yackulic, T. A. Kennedy, and J. W. Hayes. 2016. Prey size and availability limits maximum size of Rainbow Trout in a large tailwater: insights from a drift-foraging bioenergetics model. Canadian Journal of Fisheries and Aquatic Sciences 73(5):1-14.

Dreves, D. P., J. R. Ross, and J. T. Kosa. 2016. Effect of trophy regulations and reservoir discharge on a population of stocked Brown Trout in a large, southeastern United States tailwater. Journal of the Southeastern Association of Fish and Wildlife Agencies 3:167-177.

Elliott, J. M. 2000. Pools as refugia for Brown Trout during two summer droughts: trout responses to thermal and oxygen stress. Journal of Fish Biology 56:938-948.

Ensign, W. E., R. J. Strange, and S. E. Moore. 1990. Summer food limitation reduces brook and Rainbow Trout biomass in a southern Appalachian stream. Transactions of the American Fisheries Society 119:894-901.

Filbert, R. B, and C. P. Hawkins. 1995. Variation in condition of Rainbow Trout in relation to food, temperature, and individual length in the Green River, Utah. Transactions of the American Fisheries Society 124:824-835.

Flinders, J. M., and D. D. Magoulick. 2017. Spatial and temporal consumption dynamics of trout in catch-and-release areas in Arkansas tailwaters. Transactions of the American Fisheries Society 146:432-499.

Fox, C. N., and J. W. Neal. 2011. Development of a crowded largemouth bass population in a tropical reservoir. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 65:98-104.

Habera, J.W. (editor). 2017. Trout management plan for Tennessee 2017-2027. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 1999. Region IV trout fisheries report: 1998. Fisheries Report No. 99-04. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. J. Strange, and R. D. Bivens. 2001a. A revised outlook for Tennessee's brook trout. Journal of the Tennessee Academy of Science 76:68-73.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2001b. Region IV trout fisheries report: 2000. Fisheries Report No. 01-03. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2003. Region IV trout fisheries report: 2002. Fisheries Report No. 03-03. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2004. Region IV trout fisheries report: 2003. Fisheries Report No. 04-04. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2006. Region IV trout fisheries report: 2005. Fisheries Report No. 06-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2008. Region IV trout fisheries report: 2007. Fisheries Report No. 08-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2009. Region IV trout fisheries report: 2008. Fisheries Report No. 09-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., M. A. Kulp, S. E. Moore, and T. B. Henry. 2010. Three-pass depletion sampling accuracy of two electric fields for estimating trout abundance in a low-conductivity stream with limited habitat complexity. North American Journal of Fisheries Management 30:757-766.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2011. Region IV trout fisheries report: 2010. Fisheries Report No. 11-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2014a. Region IV trout fisheries report: 2013. Fisheries Report No. 14-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, and B. D. Carter. 2014b. Management plan for the Norris Tailwater trout fishery 2014-2019. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2015a. Region IV trout fisheries report: 2014. Fisheries Report No. 15-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, and B. D. Carter. 2015b. Management plan for the Wilbur Tailwater trout fishery 2015-2020. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, and B. D. Carter. 2015c. Management plan for the South Holston Tailwater trout fishery 2015-2020. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2016. Region IV trout fisheries report: 2015. Fisheries Report No. 16-04. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2017. Region IV trout fisheries report: 2016. Fisheries Report No. 17-02. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., S. J. Petre, B. D. Carter, and C. E. Williams. 2018a. Region IV trout fisheries report: 2017. Fisheries Report No. 18-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., S. J. Petre, B. D. Carter, and C. E. Williams. 2018b. Management plan for the Boone and Fort Patrick Henry tailwater trout fisheries 2019-2024. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., and B. D. Carter. 2008. Access denied: keeping the rainbows out of Left Prong. Tennessee Wildlife 31(6):21-24.

Harris, A. 2010. Trout fishing in 2006: a demographic description and economic analysis (addendum to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation). Report 2006-6. U.S. Fish and Wildlife Service, Arlington, Virginia.

Higgins, J. M. 1978. Water quality progress in the Holston River basin. TVA Division of Environmental Planning, Chattanooga, Tennessee. TVA/EP-78/08.

Hill, D. M. 1978. Tailwater trout management. Pages 66-75 in Southeastern trout resource: ecology and management symposium proceedings. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina.

Hill, D. M., and S. R. Brown. 1980. The fishery resource of Tennessee Valley tailwaters—Cherokee. TVA Division of Water Resources, Norris, Tennessee.

Holbrook, C., and P. W. Bettoli. 2006. Spawning habitat, length at maturity, and fecundity of Brown Trout in Tennessee tailwaters. Fisheries Report No. 06-11. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Hoxmeier, R. J. H., and D. J. Dieterman. 2013. Seasonal movement, growth and survival of brook trout in sympatry with Brown Trout in Midwestern US streams. Ecology of Freshwater Fish 22:530-542.

Hoxmeier, R. J. H., and D. J. Dieterman. 2016. Long-term population demographics of native brook trout following manipulative reduction of an invader. Biological Invasions 18(10).

Hudy, M., T. M. Thieling, N. Gillespie, and E. P. Smith. 2008. Distribution, status, and land use characteristics of subwatersheds within the native range of brook trout in the eastern United States. North American Journal of Fisheries Management 28:1069-1085.

Huntsman, B. M. and J. T. Petty. 2014. Density-dependent regulation of brook trout population dynamics along a core-periphery distribution gradient in a central Appalachian watershed. PLoS One 9(3): e91673. doi:10.1371/journal.pone.0091673

Hutt, C. P., and Bettoli, P. W. 2003. Recreational specialization, preferences, and management attitudes of trout anglers utilizing Tennessee tailwaters. Fisheries Report No. 03-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Johnson, J. H., and D. S. Dropkin. 1996. Seasonal habitat use by brook trout, Salvelinus fontinalis (Mitchill), in a second-order stream. Fisheries Management and Ecology 3:1-11.

King, W. 1937. Notes on the distribution of native speckled and rainbow trout in the streams of Great Smoky Mountains National Park. Journal of the Tennessee Academy of Science 12:351-361.

Korman, J., M. Yard, and T. A. Kennedy. 2017. Trends in Rainbow Trout recruitment, abundance, survival, and growth during a boon-and-bust cycle in a tailwater fishery. Transactions of the American Fisheries Society 146:1043-1057.

Kriegler, F. J., G. F. McCracken, J. W. Habera, and R. J. Strange. 1995. Genetic characterization of Tennessee's brook trout populations and associated management implications. North American Journal of Fisheries Management 15:804-813.

Kulp, M. A. 1994. A comparative ecology study of two strains of brook trout in Great Smoky Mountains National Park. MS thesis, Tennessee Technological University, Cookeville, Tennessee.

Larson, G. L., S. E. Moore, and B. Carter. 1995. Ebb and flow of encroachment by nonnative Rainbow Trout in a small stream in the southern Appalachian Mountains. Transactions of the American Fisheries Society 124:613-622.

Lewis, S. L. 1969. Physical factors influencing fish populations in pools of a trout stream. Transactions of the American Fisheries Society 98:14-19.

Lobon-Cervia, J. 2007. Density-dependent growth in stream-living Brown Trout Salmo trutta L. Functional Ecology 21:117-124.

Lohr, S. C., and J. L. West. 1992. Microhabitat selection by Brook and Rainbow Trout in a southern Appalachian stream. Transactions of the American Fisheries Society 121:729-736.

Luecke, C., T. C. Edwards, Jr., M. W. Wengert, Jr., S. Brayton, and R. Schneidervin. 1994. Simulated changes in lake trout yield, trophies, and forage consumption under various slot limits. North American Journal of Fisheries Management 14:14-21.

Maillett, E. and R. Aiken. 2015. Trout fishing in 2011: a demographic description and economic analysis, addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Report 2011-4. U.S. Fish and Wildlife Service.

Matthews, K. R., N. H. Berg, D. L. Azuma, and T. R. Lambert. 1994. Cool water formation and trout habitat use in a deep pool in the Sierra Nevada, California. Transactions of the American Fisheries Society 123:549-564.

McKinney, T., D. W. Speas, R. S. Rogers, and W. R. Persons. 2001. Rainbow Trout in a regulated river below Glen Canyon Dam, Arizona, following increased minimum flows and reduced discharge variability. North American Journal of Fisheries Management 21:216-222.

McMichael, G. A., and C. M. Kaya. 1991. Relations among stream temperature, angling success for rainbow and Brown Trout, and fishermen satisfaction. North American Journal of Fisheries Management 11:190-199.

Meerbeek, J., and P. W. Bettoli. 2005. Survival, growth, condition, and diet of stocked Brown Trout in five Tennessee tailwaters. Fisheries Report No. 05-05. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Meyer, K. A., B. High, and F. S. Elle. 2012. Effects of stocking catchable-sized hatchery Rainbow Trout on wild Rainbow Trout abundance, survival, growth, and recruitment. Transactions of the American Fisheries Society 141:224-237.

Mork, M. D. 2011. Survival and movements of large Brown Trout in a regulated river system in east Tennessee. MS thesis, Tennessee Technological University, Cookeville, Tennessee.

Myers, B. J. E., C. A. Dolloff, and A. L. Rypel. 2014. Rainbow Trout versus brook trout biomass and production under varied climate regimes in small southern Appalachian streams. Pages 127-134 in R. F. Carline, editor. Wild Trout IX: Looking back and moving forward. Wild Trout Symposium, Bozeman, Montana.

Nagel, J. W. 1986. Brook trout / Rainbow Trout headwaters competition studies. Research progress report submitted to Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Nagel, J. W. 1991. Is the decline of brook trout in the southern Appalachians resulting from competitive exclusion and/or extinction due to habitat fragmentation? Journal of the Tennessee Academy of Science 66:141-143.

Nagel, J. W., and J. E. Deaton. 1989. Growth and longevity of Rainbow Trout in two headwater streams in northeastern Tennessee. Journal of the Tennessee Academy of Science 64:9-12.

Noble, R. L., and T. W. Jones. 1999. Managing fisheries with regulations. Pages 455-480 in C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Olson, C. I., G. B. Beaubien, A. D. McKinney, and R. R. Otter. 2019. Identifying contaminants of potential concern in remote headwater streams of Tennessee's Appalachian Mountains. Environmental Monitoring and Assessment 191:176. https://doi.org/10.1007/s10661-019-7305-7

Page, L. M., H. Espinosa-Pèrez, L. T. Findley, C. R. Gilbert, R. N. Lea, N. E. Mandrak, R. L. Mayden, and J. S. Nelson. 2013. Common and scientific names of fishes from the United States, Canada, and Mexico, 7th edition. American Fisheries Society, Special Publication 34, Bethesda, Maryland.

Pedicillo, G, A. Carosi, L. Ghetti, and M. Lorenzoni. 2010. Population size structure indices and growth standards for Salmo (trutta) trutta Linnaeus, 1758 in central Italy. Knowledge and Management of Aquatic Ecosystems 399(02). doi:10.1051/kmae/2010030.

Pender, D. R., and T. J. Kwak. 2002. Factors influencing Brown Trout reproductive success in Ozark tailwater rivers. Transactions of the American Fisheries Society 131:698-717.

Peterson, J. T., R. F. Thurow, and J. W. Guzevich. 2004. An evaluation of multipass electrofishing for estimating the abundance of stream-dwelling salmonids. Transactions of the American Fisheries Society 113:462-475.

Pfitzer, D. W. 1962. Investigations of waters below large storage reservoirs in Tennessee. D-J-R Project F-1-R. Tennessee Game and Fish Commission, Nashville, Tennessee.

Power, M., and G. Power. 1996. Comparing minimum-size and slot limits for brook trout management. North American Journal of Fisheries Management 16:49-62.

Roddy, D., editor. 2018. Coldwater fish production—statewide hatchery report: 2017. Fisheries Report No. 18-02. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Roghair, C. N., C. A. Dolloff, and M. K. Underwood. 2002. Response of a brook trout population and instream habitat to a catastrophic flood and debris flow. Transactions of the American Fisheries Society 131:718-730.

Sánchez-Hernández, J., S. L. Shaw, F. Cobo, and M. S. Allen. 2016. Influence of a minimum-length limit regulation on wild Brown Trout: an example of recruitment and growth overfishing. North American Journal of Fisheries Management 36:1024-1035.

Schexnayder, S. M., A. Griffin, and J. M. Fly. 2014. Fishing participation and attitudes of anglers in Tennessee, 2012. Human Dimensions Research Lab, Department of Forestry, Wildlife and Fisheries. University of Tennessee, Knoxville, Tennessee.

Scott, E. M., K. D. Gardner, D. S. Baxter, and B. L. Yeager. 1996. Biological and water quality responses in tributary tailwaters to dissolved oxygen and minimum flow improvements. Tennessee Valley Authority, Water Management Services, Norris, Tennessee.

Shields, R. A. 1950. A survey of east Tennessee trout streams with recommendations for management. Internal report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Sotiropoulos, J. C., K. H. Nislow, and M. R. Ross. 2006. Brook trout, Salvelinus fontinalis, microhabitat selection and diet under low summer stream flows. Fisheries Management and Ecology 13:149-155.

Stitt, B. C., G. Burness, K. A. Burgonmaster, S. Currie, J. L. McDermid, and C. C. Wilson. 2014. Intraspecific variation in thermal tolerance and acclimation capacity in brook trout (Salvelinus fontinalis): Physiological implications for climate change. Physiological and Biochemical Zoology 87:15-29.

Strange, R. J., and J. W. Habera. 1992. Wild trout project: 1991 annual report. Publication No. R11-2216-76-001-92. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1993. Wild trout project: 1992 annual report. Publication No. R11-2216-76-001-93. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1995. Wild trout project: 1994 annual report. Publication No. R11-2217-18-001-95. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1996. Wild trout project: 1995 annual report. Publication No. R11-2217-93-001-96. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1997. Wild trout project: 1996 annual report. Publication No. R11-2217-93-001-97. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1998. No net loss of brook trout distribution in areas of sympatry with Rainbow Trout in Tennessee streams. Transactions of the American Fisheries Society 127:434-440.

Stranko, S. A., R. H. Hilderbrand, R. P. Morgan II, M. W. Staley, A. J. Becker, A. Roseberry-Linclon, E. S. Perry, and P. T. Jacobson. 2008. Brook trout declines with land cover and temperature changes in Maryland. North American Journal of Fisheries Management 28:1223-1232.

Swink, W. D. 1983. Survey of stocking of tailwater trout fisheries in the southern United States. Progressive Fish-Culturist 45(2):67-71.

Tarzwell, C. M. 1939. Changing the Clinch River into a trout stream. Transactions of the American Fisheries Society 68:228-233.

Tatum, R. 1968. Brook trout streams in upper east Tennessee. Internal memorandum, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

TDEC (Tennessee Department of Environment and Conservation). 2013. State of Tennessee water quality standards: use classifications for surface waters, chapter 0400-40-04. Water Quality Control Board, Nashville.

TDEC (Tennessee Department of Environment and Conservation). 2015. State of Tennessee water quality standards: general water quality criteria, chapter 0400-40-03. Water Quality Control Board, Nashville.

TWRA (Tennessee Wildlife Resources Agency). 1998. Stream survey protocols. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

TWRA (Tennessee Wildlife Resources Agency). 2014. Protecting, preserving, and perpetuating Tennessee's wildlife and ecosystems: Strategic plan 2014-2020. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

TWRA (Tennessee Wildlife Resources Agency). 2017. Trout management Plan for Tennessee 2017-2027 (J. Habera, editor). Tennessee Wildlife Resources Agency, Nashville, Tennessee.

TVA (Tennessee Valley Authority). 1980. Improving reservoir releases. TVA Office of Natural Resources and Environmental Development, Knoxville, Tennessee.

Thompson, P. D., and F. J. Rahel. 1996. Evaluation of depletion-removal electrofishing of brook trout in small Rocky Mountain streams. North American Journal of Fisheries Management 16:332-339.

Trumbo, B., M. Hudy, E. P. Smith, D.-Y. Kim, B. A. Wiggins, K. H. Nislow, and C. A. Dolloff. 2010. Sensitivity and vulnerability of brook trout populations to climate change. Pages 62-68 in R. F. Carline and C. LoSapio, editors. Wild Trout X: Conserving wild trout. Wild Trout Symposium, Bozeman, Montana.

Verhille, C. E, K. K. English, D. E. Cocherell, A. P. Farrell, and N. A. Fangue. 2016. High thermal tolerance of a Rainbow Trout population near its southern range limit suggests local thermal adjustment. Conservation Physiology 4(1):1-12.

Vøllestad, L. A., E. M. Olsen, and T. Forseth. 2002. Growth-rate variation in Brown Trout in small neighbouring streams: evidence for density-dependence? Journal of Fish Biology 61:1513-1527.

Walters, C. J., and J. R. Post. 1993. Density-dependent growth and competitive asymmetries in size-structured fish populations: a theoretical model and recommendations for field experiments. Transaction of the American Fisheries Society 122:34-45.

Warren, D. R., A. G. Ernst, and B. P. Baldigo. 2009. Influence of spring floods on year-class strength of fall- and spring-spawning salmonids in Catskill Mountain streams. Transaction of the American Fisheries Society 138:200-210.

Waters, T. F. 1999. Long-term trout production in Valley Creek, Minnesota. Transaction of the American Fisheries Society 128:1151-1162.

Weaver, D. M., and T. J. Kwak. 2013. Assessing effects of stocked trout on nongame fish assemblages in southern Appalachian Mountain streams. Transaction of the American Fisheries Society 142:1495-1507.

Weiland, M. A., and R. S. Hayward. 1997. Cause for the decline of large Rainbow Trout in a tailwater fishery: too much putting or too much taking? Transaction of the American Fisheries Society 126:758-773.

Whitworth, W. E., and R. J. Strange. 1983. Growth and production of sympatric brook and Rainbow Trout in an Appalachian stream. Transaction of the American Fisheries Society 112:469-475.

Wilde, G. R. 1997. Largemouth bass fishery responses to length limits. Fisheries 22:14-23.

Wiley, R. W., R. A. Whaley, J. B. Satake, and M. Fowden. 1993. Assessment of stocking hatchery trout: a Wyoming perspective. North American Journal of Fisheries Management 13:160-170.

Wilkins, L. P., L. Kirkland, and A. Hulsey. 1967. The management of trout fisheries in reservoirs having a self-sustaining warm water fishery. Pages 444-452 in C. E. Lane, symposium chairman. Reservoir Fishery Resources Symposium, Reservoir Committee, Southern Division, American Fisheries Society, Bethesda, Maryland.

Willis, D. W., B. R. Murphy, and C. S. Guy. 1993. Stock densities: development, use, and limitations. Reviews in Fisheries Science 1(3):203-222.

Yard, M. D., J. Korman, C. J. Walters, and T. A. Kennedy. 2015. Seasonal and spatial patterns of growth of Rainbow Trout in the Colorado River in Grand Canyon, Arizona. Canadian Journal of Fisheries and Aquatic Sciences 73:125-139.

Yeager, B. L., D. M. Hill, W. M. Seawell, C. M. Alexander, and R. Wallus. 1987. Effects of aeration and minimum flow enhancement on the biota of Norris tailwater. TVA Office of Natural Resources and Environmental Development, Knoxville, Tennessee.

Yeager, B. L., T. A. McDonough, and D. A. Kenny. 1993. Growth, feeding and movement of trout in South Holston tailwater. Water Management Services, WM-94-003. Tennessee Valley Authority, Norris, Tennessee.

APPENDIX A

Quantitative Wild Trout Stream Samples
1991-2018

Table A-1. Wild trout streams sampled quantitatively during 1991-2018.

Stream	Watershed	County	Location	Year	Primary species[1]	Total samples
Gee Creek	Hiwassee	Polk	CNF	1993	RBT	1
Rymer Camp Branch	Hiwassee	Polk	CNF	1994	RBT	1
Sulphur Springs Branch	Hiwassee	Polk	CNF	1992	RBT	1
East Fork Wolf Creek	Hiwassee	Polk	CNF	1995	RBT	1
Big Creek	Ocoee	Polk	CNF	1996	RBT	1
Goforth Creek	Ocoee	Polk	CNF	1993	RBT	1
Rough Creek	Ocoee	Polk	CNF	1995	RBT	1
Tellico River[2]	L. Tennessee	Monroe	CNF	1993,95-02, 06, 11, 14	RBT/BNT	32
Bald River[3]	Tellico	Monroe	CNF	1991-00, 05, 07, 10, 13	RBT/BNT/BKT	39
Kirkland Creek	Tellico	Monroe	CNF	1991	RBT	1
Henderson Branch	Tellico	Monroe	CNF	1996	RBT/BNT/BKT	2
Brookshire Creek	Tellico	Monroe	CNF	1996	BKT	3
North River[2]	Tellico	Monroe	CNF	1991-14	RBT/BNT	72
Laurel Branch	Tellico	Monroe	CNF	1997	RBT/BNT	1
Sugar Cove Creek	Tellico	Monroe	CNF	1995-96	RBT/BKT	3
Meadow Branch	Tellico	Monroe	CNF	1991,95, 04	BKT	6
Sycamore Creek	Tellico	Monroe	CNF	1994-95,97-98	RBT/BKT	6
Rough Ridge Creek	Tellico	Monroe	CNF	1995	RBT/BKT	2
Citico Creek	L. Tennessee	Monroe	CNF	1996	RBT/BNT	1
Doublecamp Creek	L. Tennessee	Monroe	CNF	1992	RBT/BNT	2
S. Fork Citico Creek	L. Tennessee	Monroe	CNF	2004	RBT	1
N. Fork Citico Creek	L. Tennessee	Monroe	CNF	2003	RBT	1
Parson Branch	L. Tennessee	Blount	Private	1993	RBT	1
Slickrock Creek	L. Tennessee	Monroe	CNF	2007	BNT	2
Little Slickrock Creek	L. Tennessee	Monroe	CNF	2007	BNT	1
Dunn Creek	French Broad	Sevier	Private	1993	RBT	1
Indian Camp Creek	French Broad	Cocke	Private	2007	RBT	1
Sinking Creek	French Broad	Cocke	Private	1999	RBT	1
Tobes Creek	French Broad	Cocke	Private	2006	RBT	1
Gulf Fork Big Creek	French Broad	Cocke	Private	1993, 04, 08	RBT/BNT	3
Deep Gap Creek	French Broad	Cocke	State Forest	2005	RBT	1
Laurel Creek	French Broad	Cocke	State Forest	2013	RBT	1
M. Prong Gulf Creek	French Broad	Cocke	Private	1991	BKT	1
Brown Gap Creek	French Broad	Cocke	Private	1991	BKT	1
Trail Fork Big Creek	French Broad	Cocke	CNF	1996, 2001	RBT	2
Dry Fork	French Broad	Cocke	CNF	1994	BKT/RBT	2
Wolf Creek	French Broad	Cocke	CNF	1993	RBT	2
Paint Creek[2]	French Broad	Greene	CNF	92, 94, 95, 02-04, 08, 11, 14, 17	BNT/RBT	17
Sawmill Branch	French Broad	Greene	CNF	1999	BKT/BNT	1
Little Paint Creek	French Broad	Greene	CNF	1993	BKT	1

Table A-1 (cont.). Wild trout streams sampled quantitatively during 1991-2018.

Stream	Watershed	County	Location	Year	Primary species[1]	Total samples
Jennings Creek	Nolichucky	Greene	CNF	1992, 14	RBT	2
Round Knob Branch	Nolichucky	Greene	CNF	1996	BKT	1
Dry Creek	Nolichucky	Greene	CNF	1992	RBT	1
Davis Creek	Nolichucky	Greene	CNF	1992, 2003	RBT/BKT	2
W. Fork Dry Creek	Nolichucky	Greene	CNF	1992	BKT	1
Horse Creek	Nolichucky	Greene	CNF	1994	RBT	1
Squibb Creek	Nolichucky	Greene	CNF	1991, 2003	RBT/BKT	2
Sarvis Cove Creek	Nolichucky	Greene	CNF	1991, 2003	RBT/BKT	2
Cassi Creek	Nolichucky	Greene	CNF	2003	RBT	1
Painter Creek	Nolichucky	Washington	Private	1993	RBT	1
Clark Creek	Nolichucky	Unicoi	CNF	1991	RBT	1
Sill Branch	Nolichucky	Unicoi	CNF	1994	RBT	1
Devil Fork	Nolichucky	Unicoi	CNF	1999	RBT	1
Longarm Branch	Nolichucky	Unicoi	CNF	1997	RBT	1
Dry Creek	Nolichucky	Washington	CNF	1997	RBT	1
Ramsey Creek	Nolichucky	Washington	Private	1996	RBT	1
Briar Creek[2]	Nolichucky	Washington	CNF	1992,95-18	RBT/BKT	25
Straight Creek	Nolichucky	Washington	CNF	2003	BKT	1
Broad Shoal Creek	Nolichucky	Unicoi	CNF	1991	RBT	1
N. Indian Creek	Nolichucky	Unicoi	CNF	1994-95, 03	RBT/BNT	3
Rock Creek	Nolichucky	Unicoi	CNF	1991	RBT/BKT	1
R. Prong Rock Creek	Nolichucky	Unicoi	CNF	1998	RBT	1
Red Fork	Nolichucky	Unicoi	CNF	1998	RBT	1
Clear Fork	Nolichucky	Unicoi	CNF	1993	BKT	1
South Indian Creek	Nolichucky	Unicoi	Private	2009	RBT	1
Mill Creek	Nolichucky	Unicoi	CNF	1996	RBT	1
Granny Lewis Creek	Nolichucky	Unicoi	CNF	1991	RBT	2
Higgins Creek (Lower)	Nolichucky	Unicoi	Private	1992,95	BKT/RBT	2
Spivey Creek	Nolichucky	Unicoi	Private	2007	RBT	1
Coffee Ridge	Nolichucky	Unicoi	Private	2011	RBT	1
Big Bald Creek	Nolichucky	Unicoi	Private	1996	RBT	1
Tumbling Creek	Nolichucky	Unicoi	Private	1995	RBT	1
Little Bald Creek	Nolichucky	Unicoi	Private	2007	RBT	1
Big Branch	Nolichucky	Unicoi	Private	1996	RBT	1
Rocky Fork[2]	Nolichucky	Unicoi/Greene	Private	1991-18	RBT/BKT	54
Rice Creek	Nolichucky	Unicoi	Private	1995	RBT	1
Higgins Creek (Upper)	Nolichucky	Unicoi	Private	2006	RBT	1
Sams Creek	Nolichucky	Unicoi	Private	2002	RBT	1
Jones Branch	Nolichucky	Unicoi	CNF	1991	BKT	1
Buffalo Creek	Watauga	Unicoi/Carter	Private	1998, 02	RBT	2

Table A-1 (cont.). Wild trout streams sampled quantitatively during 1991-2018.

Stream	Watershed	County	Location	Year	Primary species[1]	Total samples
Doe River[2]	Watauga	Carter	Private	1995-99, 02-04, 09, 12, 15, 18	RBT/BKT/BNT	15
Laurel Fork[2]	Watauga	Carter	CNF	1991-01, 03, 06, 09, 12, 15, 18	BNT	33
Little Laurel Fork	Watauga	Carter	CNF	1994	BKT	1
Leonard Branch	Watauga	Carter	CNF	2011	BKT/BNT	1
Wagner Branch	Watauga	Carter	CNF	1993	BKT/BNT	1
Cook Branch	Watauga	Carter	CNF	2008	BNT	1
Camp 15 Branch	Watauga	Carter	CNF	2011	BKT/BNT	1
Camp 10 Branch	Watauga	Carter	CNF	1995	BKT	1
Little Doe River	Watauga	Carter	Private	2010	RBT/BNT	1
Simerly Creek	Watauga	Carter	Private	1994, 2010	RBT/BNT	2
Sally Cove Creek	Watauga	Carter	Private	1995	RBT	1
Clarke Creek	Watauga	Carter	Private	1992	BKT	1
McKinney Branch	Watauga	Carter	Private	2010	RBT/BNT	1
Tiger Creek	Watauga	Carter	CNF	1991, 99	RBT/BKT	2
Roberts Hollow	Watauga	Carter	Private	2014	RBT/BKT	1
Bill Creek	Watauga	Carter	CNF	1991	BKT	1
Roaring Creek	Watauga	Carter	Private	2011	RBT	1
George Creek	Watauga	Carter	CNF	1991	BKT	1
Buck Creek	Watauga	Carter	CNF/Private	1997	RBT	2
Shell Creek	Watauga	Carter	Private	2004	RBT	1
L. Pr. Hampton Creek[2]	Watauga	Carter	State	1994-18	RBT/BKT	67
Heaton Creek	Watauga	Carter	Private	2000	RBT	1
Toms Branch	Watauga	Carter	Private/CNF	1991, 09	BKT	2
Five Poplar Branch	Watauga	Carter	Private	2000	RBT	1
Middle Branch	Watauga	Carter	Private	1991	BKT	1
R. Pr. Middle Branch[2]	Watauga	Carter	CNF	1994, 97-18	BKT	22
Panther Branch	Watauga	Carter	CNF	1996	BKT	1
Cove Creek	Watauga	Carter	Private	1991, 12	BKT/RBT	2
Little Cove Creek	Watauga	Carter	Private	2008	RBT/BKT	1
Stony Creek	Watauga	Carter	CNF	1992, 95, 04-06, 10, 13, 16	RBT/BKT/BNT	9
Little Stony Creek	Watauga	Carter	CNF	1992	BKT	1
Furnace Branch	Watauga	Carter	CNF	2003	BKT	1
Mill Creek	Watauga	Carter	Private	1994	BKT	1
North Fork Stony Creek	Watauga	Carter	CNF	1991	BKT	1
Lindy Camp Branch	Watauga	Carter	CNF	2008	BKT	1
Little Stony Creek[4]	Watauga	Carter	CNF	1993, 2014	RBT/BKT	2
Roan Creek	Watauga	Johnson	Private	1997	RBT/BKT	2
Doe Creek[2]	Watauga	Johnson	Private	1993-18	RBT	27
Goose Creek	Watauga	Johnson	Private	2006	RBT/BNT	1

Table A-1 (cont.). Wild trout streams sampled quantitatively during 1991-2018.

Stream	Watershed	County	Location	Year	Primary species[1]	Total samples
Forge Creek	Watauga	Johnson	Private	1993	RBT/BKT	2
Roaring Creek	Watauga	Johnson	Private	2001	RBT	1
Bulldog Creek	Watauga	Johnson	Private	2009	RBT	1
Big Dry Run	Watauga	Johnson	Private	1994	RBT	1
Heaton Branch	Watauga	Carter	Private	1994	RBT	1
Little Laurel Branch	Watauga	Carter	CNF	1992	BKT	1
Trivett Branch	Watauga	Carter	Private	1996	BNT	1
Big Creek	S. F. Holston	Sullivan	CNF	1994	RBT	1
Fishdam Creek	S. F. Holston	Sullivan	CNF	1991, 2005	RBT	2
Sharps Creek	S. F. Holston	Sullivan	CNF	2012	RBT	1
Little Jacob Creek	S. F. Holston	Sullivan	CNF	1991, 2000	RBT	2
Rockhouse Run	S. F. Holston	Sullivan	CNF	1993	BKT	1
Laurel Creek[2]	S. F. Holston	Johnson	CNF	1993-94, 01-02, 04, 07, 10, 13, 16	RBT/BNT	9
Beaverdam Creek[2]	S. F. Holston	Johnson	CNF	1991-17	RBT/BNT	54
Tank Hollow	S. F. Holston	Johnson	CNF	2003	BKT	1
Chalk Branch	S. F. Holston	Johnson	CNF	1994	BKT	1
Maple Branch	S. F. Holston	Johnson	CNF	1994	BKT	1
Fagall Branch	S. F. Holston	Johnson	CNF	1995	BKT	1
Birch Branch[2]	S. F. Holston	Johnson	CNF/Private	1991,95-16, 18	BKT/RBT	24
Marshall Branch	S. F. Holston	Johnson	CNF	1999	BKT	1
Heaberlin Branch	S. F. Holston	Johnson	CNF	1993	BKT	1
Johnson Blevins Br.	S. F. Holston	Johnson	Private	1991	BKT	1
Jim Wright Branch	S. F. Holston	Johnson	Private	1991	BKT	1
E. Fk. Beaverdam Ck.	S. F. Holston	Johnson	CNF	1992	BKT	1
Valley Creek	S. F. Holston	Johnson	CNF	1993	BKT	1
Owens Branch	S. F. Holston	Johnson	CNF	1995	RBT/BNT	1
Lyons Branch	S. F. Holston	Johnson	CNF	1992	RBT	1
Gentry Creek[2]	S. F. Holston	Johnson	CNF	1992,96-16, 18	RBT/BKT	24
Grindstone Branch	S. F. Holston	Johnson	CNF	1996	BKT	1
Kate Branch	S. F. Holston	Johnson	CNF	2000	BKT	1
Atchison Branch	S. F. Holston	Johnson	Private	2006	RBT	1

[1]RBT = Rainbow Trout; BNT = Brown Trout; BKT = Brook Trout.

[2]Monitoring stream. TWRA Region III began monitoring streams in the Tellico and Little Tennessee watersheds in 2014.

[3]Includes a site sampled in the allopatric Brook Trout zone in 1992; monitoring Site 2 was discontinued in 2010.

[4]Watauga Lake tributary.

APPENDIX B

Qualitative Stream Surveys
1991-2018

Table B-1. Streams sampled qualitatively during 1991-2018 to determine the presence of wild trout.

Stream	Watershed	County	Location	Coordinates	Survey date	Wild trout present[1]
Smith Creek	Hiwassee	Polk	CNF	35.15135, -84.42420	Nov-99	RBT
Coker Creek	Hiwassee	Monroe	Private	35.26978, -84.26283	Jul-96	None
Wolf Creek	Hiwassee	Polk	CNF	35.16522, -84.38135	May-99	RBT/BNT
Wildcat Creek	Tellico	Monroe	CNF	35.29894, -84.25793	Jul-96	None
Natty Creek	Tellico	Monroe	CNF	35.31705, -84.22875	Jul-96	None
Tobe Creek	Tellico	Monroe	CNF	35.29990, -84.22923	Jul-96	None
Laurel Branch	French Broad	Sevier	Private	35.77184, -83.39841	Jul-15	None
Wilhite Creek	French Broad	Sevier	Private	35.87333, -83.32037	Jul-15	None
Lin Creek	French Broad	Sevier	Private	35.86744, -83.32864	Jul-15	None
Mill Creek	French Broad	Sevier	Private	35.73479, -83.57456	Jul-15	RBT
Indian Camp Creek (lower)	French Broad	Cocke	Private	35.77938, -83.26361	Jun-06	RBT
Indian Camp Creek (lower)	French Broad	Cocke	Private	35.77622, -83.26537	Jun-06	RBT, BKT
Indian Camp Creek (lower)	French Broad	Cocke	Private	37.77337, -83.26657	Jun-06	RBT, BKT
Greenbrier Creek	French Broad	Cocke	Private	35.78278, -83.24322	Jun-06	RBT
Groundhog Creek	French Broad	Cocke	Private	35.78918, -83.18387	Jul-15	RBT
Robinson Creek	French Broad	Cocke	Private	35.79097, -83.19433	Jul-15	RBT
John Creek	French Broad	Cocke	Private	35.86611, -83.03250	Jun-01	None
Baker Branch	French Broad	Cocke	Private	35.86306, -83.03083	Jun-01	None
Tom Creek	French Broad	Cocke	Private	35.85306, -83.01806	Jun-01	RBT3
Gulf Fork Big Creek	French Broad	Cocke	Private	35.82385, -83.09162	May-07	RBT/BNT
Gulf Fork Big Creek	French Broad	Cocke	Private	35.83037, -83.05730	May-07	RBT/BNT
Gulf Fork Big Creek	French Broad	Cocke	Private	35.82064, -83.04665	May-07	RBT/BNT
Gulf Fork Big Creek	French Broad	Cocke	Private	35.81805, -83.04191	May-07	RBT/BNT
Laurel Fork (upper)	French Broad	Cocke	CNF	35.88146, -83.06236	Jun-14	None
Laurel Fork (lower)	French Broad	Cocke	Private	35.89220, -83.06274	Jun-14	None
Grassy Fork	French Broad	Cocke	Private	35.81585, -83.08673	Jun-03	RBT4
Deep Gap Creek	French Broad	Cocke	State	35.79321, -83.02074	Oct-06	BKT
Brush Creek	French Broad	Cocke	CNF	35.95817, -82.93442	Jun-15	None
Trail Fork Big Creek	French Broad	Cocke	CNF/Private	35.83382 -82.96238	Jun-18	RBT
Paint Creek	French Broad	Greene	Private	36.00702, -82.77679	Jun-15	RBT/BNT
Paint Creek	French Broad	Greene	CNF	36.02082, -82.74602	Jun-15	RBT
Cove Creek	Nolichucky	Greene	Private	35.97882, -82.86960	Jun-15	None
Back Creek	Nolichucky	Greene	Private	36.01896, -82.80796	Jun-08	None
Camp Creek	Nolichucky	Greene	Private	36.07811, -82.76464	Jul-03	RBT
Bumpus Cove Creek	Nolichucky	Unicoi	Private	36.16941, -82.47134	Jul-07	RBT
Bumpus Cove Creek	Nolichucky	Washington	Private	36.15227, -82.49503	Jul-07	RBT/BNT
Broad Shoal Creek	Nolichucky	Unicoi	CNF	36.15229, -82.44492	Jun-08	RBT
Dry Creek	Nolichucky	Unicoi	Private	36.17448, -82.35113	Jun-10	None (dry)
Dick Creek	Nolichucky	Unicoi	CNF	36.17326, -82.31647	May-11	No fish
Rocky Branch	Nolichucky	Unicoi	Private	36.17589, -82.29530	Jun-10	None

Table B-1 (cont.). Streams sampled qualitatively during 1991-2018 to determine the presence of wild trout.

Stream	Watershed	County	Location	Coordinates	Survey date	Wild trout present[1]
Simerly Creek	Nolichucky	Unicoi	Private	36.18453, -82.25218	Jun-10	None2
South Indian Creek (upper)	Nolichucky	Unicoi	Private	36.03568, -82.55163	Jun-05	RBT
South Indian Creek (middle)	Nolichucky	Unicoi	Private	36.05937, -82.52198	Jun-05	RBT4
South Indian Creek (lower)	Nolichucky	Unicoi	Private	36.12065, -82.44834	Jul-08	RBT4
Spivey Creek (lower)	Nolichucky	Unicoi	Private	36.06566, -82.50199	Jun-06	RBT
Spivey Creek (middle)	Nolichucky	Unicoi	Private	36.05169, -82.50063	Jun-06	RBT
Spivey Creek (middle)	Nolichucky	Unicoi	Private	36.03955, -82.48652	Jun-06	RBT
Spivey Creek (upper)	Nolichucky	Unicoi	Private	36.04042, -82.47109	Jun-06	RBT
Murray Branch	Nolichucky	Unicoi	Private	36.04610, -82.51080	May-11	RBT4
Murray Branch	Nolichucky	Unicoi	Private	36.04348, -82.51683	May-11	None
Slip Creek	Nolichucky	Unicoi	Private	36.02103, -82.50891	Jun-06	RBT4
Little Bald Creek	Nolichucky	Unicoi	Private	36.03993, -82.46505	Jun-06	RBT
Pete Creek	Nolichucky	Unicoi	CNF	36.01286, -82.58934	Jun-05	None2
E. Fork Higgins Creek	Nolichucky	Unicoi	CNF	35.99601, -82.53006	Jun-05	None2
Long Branch	Nolichucky	Unicoi	CNF	36.08811, -82.42917	Jun-08	BKT
Sinking Creek (upper)	Watauga	Carter	Private	36.25559, -82.36470	Jun-06	RBT, BKT, BNT
Sinking Creek (upper)	Watauga	Carter	Private	36.25192, -82.36493	Jun-06	RBT, BKT, BNT
Sinking Creek (middle)	Watauga	Carter	Private	36.26143, -82.36430	Jun-06, Jun-18	RBT, BKT
Sinking Creek (lower)	Watauga	Carter	Private	36.27966, -82.36838	Jun-06	RBT
Basil Hollow	Watauga	Washington	Private	36.25134, -82.36456	May-07	RBT
Dry Creek	Watauga	Carter	Private	36.25910, -82.28150	Jun-09	BNT4
Honeycomb Creek	Watauga	Carter	Private	36.24304, -82.26767	Jun-09	RBT4
Gap Creek	Watauga	Carter	CNF	36.26756, -82.23016	Jun-09	None
Upper Gap Creek	Watauga	Carter	Private	36.25850, -82.23574	Jun-09	None2
Little Doe River	Watauga	Carter	Private	36.24629, -82.19464	Jun-09	RBT/BNT
Little Doe River	Watauga	Carter	Private	36.22870, -82.18899	Jun-09	RBT/BNT
Simerly Creek (lower)	Watauga	Carter	Private	36.22769, -82.18925	Jun-09	RBT/BNT
Big Flats Branch	Watauga	Carter	Private	36.24634, -82.14575	Aug-06	RBT
Firescald Branch	Watauga	Carter	CNF	36.24920, -82.08700	Nov-15	BKT
Doll Branch	Watauga	Carter	Private	36.15115, -82.02994	Jun-04	RBT
Morgan Branch	Watauga	Carter	Private	36.17449, -82.02072	Jun-08	RBT4
Bear Branch	Watauga	Carter	CNF	36.18106, -82.01066	Jun-08	RBT4
State Line Branch	Watauga	Carter	Private	36.16797, -82.00265	Jun-08	RBT4
Hampton Creek (upper)	Watauga	Carter	Private	36.14939, -82.05561	Jun-08	RBT4
Sugar Hollow Creek	Watauga	Carter	Private	36.15694, -82.07053	Jun-08	RBT4
Bearwallow Hollow	Watauga	Carter	State	36.15899, -82.10180	Jul-14	None
Nidifer Branch	Watauga	Carter	Private	36.39768, -82.09988	May-95	None2
Hinkle Branch	Watauga	Carter	Private	36.40950, -82.09707	May-95	None2
Peters Branch	Watauga	Carter	Private	36.40696, -82.07738	Jun-11	None (nearly dry)
Horselog Branch	Watauga	Carter	Private	36.40822, -82.06854	Jun-11	None (nearly dry)
Laurel Branch	Watauga	Carter	Private	36.41660, -82.07871	May-95	None2
Grindstaff Branch	Watauga	Carter	Private	36.41442, -82.05386	Jun-11	None

Table B-1 (cont.). Streams sampled qualitatively during 1991-2018 to determine the presence of wild trout.

Stream	Watershed	County	Location	Coordinates	Survey date	Wild trout present[1]
Stover Branch	Watauga	Carter	Private	36.42096, -82.05016	Jun-11	RBT4
Right Fork Mill Creek	Watauga	Carter	CNF	36.43993, -82.07787	Jun-15	BKT
Hurley Branch	Watauga	Carter	Private	36.43600, -82.04804	Jun-11	RBT/BNT
Hurley Branch	Watauga	Carter	Private	36.43150, -82.03231	Jun-11	RBT
Richardson Branch	Watauga	Carter	Private	36.45740, -82.01002	Jun-11	None (dry)
Bowen Branch	Watauga	Carter	Private	36.46105, -82.00719	Jun-11	None (dry)
Upper Hinkle Branch	Watauga	Carter	Private	36.46905, -82.00466	Jul-07	None
Big Spur Branch	Watauga	Carter	CNF	36.46786, -81.97704	Jun-15	BKT
Lindy Camp Branch	Watauga	Carter	CNF	36.47081, -81.96968	Jul-07	BKT
Baker Ridge Branch	Watauga	Carter	CNF	36.48095, -81.97507	Jun-15	BKT
Water Hollow Branch	Watauga	Carter	CNF	36.47822, -81.97452	Jun-15	BKT
Sink Branch	Watauga	Johnson	Private	36.36305, -81.99222	Jun-09	None2
Doe Creek	Watauga	Johnson	Private	36.45667, -81.87556	Oct-01	None
Doe Creek	Watauga	Johnson	Private	36.44889, -81.89889	Oct-01	RBT4
Doe Creek	Watauga	Johnson	Private	36.44194, -81.90806	Oct-01	RBT4
Dugger Branch	Watauga	Johnson	Private	36.39397, -81.96911	Jun-95	None2
Campbell Hollow	Watauga	Johnson	Private	36.40306, -81.96558	Jun-95	None2
Campbell Creek	Watauga	Johnson	CNF	36.45734, -81.95157	Sep-14	Barrier—no fish above
Spruce Branch	Watauga	Johnson	Private	36.45630, -81.88100	Jun-15	RBT
Stout Branch	Watauga	Johnson	Private	36.47544, -81.87173	Jun-15	None
Shaw Branch	Watauga	Johnson	Private	36.48240, -81.85836	Jun-15	None2
Little Dry Run	Watauga	Johnson	Private	36.35489, -81.93736	Jun-09	None2
Avery Branch	Watauga	Johnson	Private	36.36972, -81.87307	Jun-09	None2
Stout Branch	Watauga	Johnson	Private	36.36716, -81.83291	Jun-08	RBT4
Slimp Branch	Watauga	Johnson	Private	36.38751, -81.84609	Jun-08	None
Lunt Branch	Watauga	Johnson	Private	36.40488, -81.85349	Jun-08	None (dry)
Big Sandy Creek	Watauga	Johnson	Private	36.39884, -81.80691	Jun-08	None (dry)
Furnace Creek	Watauga	Johnson	Private	36.48419, -81.79864	Jun-06	RBT
East Fork (Furnace Creek)	Watauga	Johnson	Private	36.36681, -81.80068	Jun-94, Jun-15	None
Cabbage Creek	Watauga	Johnson	Private	36.40792, -81.80150	Jun-08	None (dry)
Stout Branch	Watauga	Johnson	Private	36.42797, -81.74439	Jul-97	None
E.H. Phillippi Branch	Watauga	Johnson	Private	36.49089, -81.84778	Jun-15	None2
Patrick Branch	Watauga	Johnson	Private	36.50505, -81.82793	Jun-15	None2
Thomas Branch	Watauga	Johnson	Private	36.51315, -81.83235	Jun-15	None2
Fenner Branch	Watauga	Johnson	Private	36.51606, -81.83144	Jun-15	None2
Gentry Branch	Watauga	Johnson	Private	36.51816, -81.82568	Jun-15	None2
Hall Branch	Watauga	Johnson	Private	36.51850, -81.81934	Jun-15	None2
Stone Branch	Watauga	Johnson	Private	36.52243, -81.81736	Jun-15	None2
Fall Branch	Watauga	Johnson	Private	36.42452, -81.74489	Jun-99	RBT
Woodward Branch	Watauga	Johnson	Private	36.47442, -81.72249	Jun-10	RBT4
Drake Branch	Watauga	Johnson	Private	36.36566, -81.74845	Jun-09	RBT4
Egger Branch	Watauga	Johnson	Private	36.36543, -81.76789	Jun-15	RBT4
Buttermilk Branch	Watauga	Johnson	Private	36.35035, -81.75234	Jun-15	RBT4

Table B-1 (cont.). Streams sampled qualitatively during 1991-2018 to determine the presence of wild trout.

Stream	Watershed	County	Location	Coordinates	Survey date	Wild trout present[1]
W. Fork Buttermilk Br.	Watauga	Johnson	Private	36.34703, -81.75228	Jun-15	None
Jenkins Creek	Watauga	Johnson	Private	36.35215, -81.73884	Jun-10	RBT4
'Poplar Ridge' Branch5	Watauga	Johnson	Private	36.36566, -81.74845	Jun-15	RBT
Black Branch	Watauga	Carter	Private	36.28758, -82.01163	Jul-07	RBT/BNT4
Row Branch	Watauga	Carter	Private	36.28869, -82.01325	Jul-07	RBT4
Jones Branch	Watauga	Carter	Private/CNF	36.20195, -81.98815	Jul-02	None
Baker Branch	Watauga	Johnson	Private	36.34010, -81.92116	May-96	None2
Morgan Branch	Watauga	Johnson	Private	36.32769, -81.90590	Jun-09	None
Dye Leaf Branch	Watauga	Johnson	Private	36.33538, -81.89473	Jun-09	None
Little Creek	S. Fork Holston	Sullivan	CNF	36.47529, -82.08702	Jul-15	BNT (1)
Roaring Creek	S. Fork Holston	Sullivan	CNF	36.48538, -82.08930	Jul-15	None
Josiah Creek	S. Fork Holston	Sullivan	CNF	36.49992, -82.04397	Jul-15	None2
Sulphur Springs Branch	S. Fork Holston	Sullivan	CNF	36.52238, -82.02516	Jun-05	RBT
Sharps Creek	S. Fork Holston	Sullivan	Private	36.54608, -82.01824	Jun-11	RBT4
Sharps Creek	S. Fork Holston	Sullivan	Private	32.53868, -81.99159	Jun-11	RBT
Cave Spring Branch	S. Fork Holston	Sullivan	Private	36.59283, -81.98427	Jun-11	None
Laurel Creek	S. Fork Holston	Johnson	CNF	36.52622, -81.80172	Jun-04	None
Beaverdam Creek	S. Fork Holston	Johnson	Private	36.53244, -81.92330	May-03, Jun-05	RBT/BNT
Beaverdam Creek	S. Fork Holston	Johnson	Private	36.52050, -81.93219	May-03, Jun-05	RBT/BNT
Beaverdam Creek	S. Fork Holston	Johnson	Private	36.51664, -81.93763	May-03, Jun-05	RBT/BNT
Reservoir Branch	S. Fork Holston	Johnson	Private	36.60295, -81.81103	May-96	None2
Reservoir Branch	S. Fork Holston	Johnson	Private	36.60264, -81.81086	Oct-15	RBT/BNT
Reservoir Branch	S. Fork Holston	Johnson	Private	36.59858, -81.80787	Oct-15	None
Stillhouse Branch	S. Fork Holston	Johnson	CNF	36.58489, -81.83032	Jun-04	RBT/BNT
Haunted Hollow	S. Fork Holston	Johnson	CNF	36.57662, -81.85151	Jun-04	None
Dan Wiley Branch	S. Fork Holston	Johnson	CNF	36.56981, -81.85512	Oct-15	None
Dark Hollow	S. Fork Holston	Johnson	CNF	36.57683, -81.85896	Jun-04	None
Flat Springs Branch	S. Fork Holston	Johnson	Private	36.54886, -81.88531	Aug-05	RBT/BNT
Grindstone Branch	S. Fork Holston	Johnson	Private	36.53513, -81.88837	Jun-15	None2
David Blevins Branch	S. Fork Holston	Johnson	Private	36.53357, -81.89964	Jun-06	None
McQueen Branch	S. Fork Holston	Johnson	Private	36.54262, -81.90921	Jun-06	RBT4
Green Mountain Branch	S. Fork Holston	Johnson	Private	36.50915, -81.91061	Jun-06, Jun-18	RBT
Buck Ridge Branch	S. Fork Holston	Johnson	Private	36.49639, -81.96272	Jul-04	RBT/BNT
W. Fork Beaverdam Creek	S. Fork Holston	Johnson	Private	36.49064, -81.94230	Jun-06	BKT
M. Fork Beaverdam Creek	S. Fork Holston	Johnson	Private	36.49661, -81.93719	Jun-06	RBT, BKT, BNT
Seng Cove Branch	S. Fork Holston	Johnson	Private	36.59219, -81.72168	Jun-10	None
Cave Spring Branch	S. Fork Holston	Johnson	Private	36.59002, -81.72465	Jun-10	RBT4
Shingletown Branch	S. Fork Holston	Johnson	Private	36.54533, -81.77751	Jun-04	None2
Drystone Branch	S. Fork Holston	Johnson	Private	36.52833, -81.77521	May-96	None2
Flatwood Branch	S. Fork Holston	Johnson	Private	36.52680, -81.80280	Jun-04	None2
Corum Branch	S. Fork Holston	Johnson	Private	36.52636, -81.81085	Jun-15	None2
Richardson Branch	S. Fork Holston	Johnson	CNF	36.61033, -81.67962	Jun-93	None

Table B-1 (cont.). Streams sampled qualitatively during 1991-2018 to determine the presence of wild trout.

Stream	Watershed	County	Location	Coordinates	Survey date	Wild trout present[1]
Richardson Branch	S. Fork Holston	Johnson	CNF	36.61046, -81.68022	Jun-15	BKT
Whetstone Branch	S. Fork Holston	Johnson	CNF	36.60731, -81.68474	Jun-15	BKT

[1]RBT = Rainbow Trout; BNT = Brown Trout; BKT = Brook Trout.

[2]Visually inspected and judged too small (<1 m wide) or without appropriate habitat to support wild trout.

[3]Trout present, but origin questionable; could be the result of fingerling stocking by private individuals.

[4]Low abundance.

[5]Unnamed tributary to Roan Creek on Zionville quadrangle map.